REPORT

ON THE

RAVAGES OF THE BORER

IN

COFFEE ESTATES,

WITH A

REVIEW OF THE EXISTING SYSTEMS OF COFFEE CULTURE,

AND

SUGGESTIONS FOR THE FURTHER DEVELOPMENT

OF THE

PRODUCTIVE RESOURCES OF THE COFFEE DISTRICTS IN SOUTHERN INDIA

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MADRAS, 3rd *August* 1868.

From

SURGEON GEORGE BIDIE, M.B.,

To

THE HONORABLE R. S. ELLIS, C.B.,

Chief Secretary to Government,

Fort St. George.

SIR,—I have the honor to forward, for the information of Government, the following report on the ravages of the Borer in Coffee Estates, which I was directed to undertake in G. O., Public Department, No. 1311, dated 22nd October 1867. To avoid repetition, and bring the whole of my remarks together, I have thought it better to prepare one general Report, instead of a distinct one for each district; and trust that this will meet with the approval of the authorities to whom it is addressed. As the investigation progressed, I found it absolutely necessary, in order to arrive at satisfactory conclusions, to consider nearly every point connected with Coffee culture, and, to render this communication complete, it will be necessary to review the several matters that occupied my attention.

I have, &c.,

GEORGE BIDIE, M.B.,

Commissioner for Investigating the ravages of the Borer in Coffee Estates.

REPORT

ON THE

RAVAGES OF THE BORER IN COFFEE ESTATES.

I.—ORIGIN AND DEVELOPMENT OF COFFEE CULTURE IN SOUTHERN INDIA.

The Coffee plant cultivated in Southern India is the *Coffea Arabica,* and a native of Caffa in Southern Abyssinia. Several varieties exist, but none of them differs sufficiently from the original to entitle it to the rank of a distinct species. Some of the plants have been raised from seed brought from Ceylon; but coffee was first introduced into India upwards of two centuries ago by a Mussulman pilgrim, Bababooden. This man, on his return from Mecca, brought a few berries in his wallet, and taking up his abode amid the fastnesses of the hills in Mysore that still bear his name, planted them near his hut. The trees raised from these were gradually multiplied, and no doubt the greater portion of the coffee now growing in Southern India has been derived from this stock. For a long time subsequent to its introduction, the cultivation of the plant does not seem to have extended beyond the Fakeer's garden, and it is only within the last sixty or seventy years that it has been taken up in other parts of the country. Indeed, while Mysore was under Native rule, no encouragement was given for its extension, and the cultivator was fettered with oppressive taxes levied by men who farmed the revenue. When the country came under British rule, things were changed for the better, and what is called the *Haulet system* introduced. Under this the planter pays a duty on every maund of produce, and it is curious to notice how coffee culture has extended as the rate of taxation has been reduced, and other liberal measures brought into operation.

No doubt the greatest stimulus has been given to it by the increased value of the produce; a hundred-weight of coffee at the

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present day, being worth double what it was some years ago. In 1848, in Ceylon, a hundred-weight of native coffee was sold for the same price as a bushel of rice, viz., 4½ Rupees, and about the same time estate coffee from Wynaad was selling on the coast for 17 Rupees the hundred-weight. At present, estate coffee is worth from 30 to 34 Rupees the hundred-weight, and although the working expenses of estates have greatly increased of late, still the rise is insignificant as compared with the marvellous improvement in prices. About forty years ago coffee culture in Southern India was entirely in the hands of Natives, but since that period, it has been gradually taken up by the more enterprising and energetic European. One of the first in the field was Mr. Cannon, and his estate, situated on a high range immediately to the south of the Bababoodens, is still in existence, the original coffee plants flourishing under the shade of the primitive jungle. Some years after, several estates were opened in the Wynaad, and on the Neilgherries, but for a considerable period, operations hardly extended beyond the stage of experiment. From ten to twelve years ago, the high price of land, and flourishing state of coffee culture in Ceylon, induced planters from that island to come over to India, and their presence and efforts gave a great impetus to coffee culture. The demand for land rapidly grew in every part of the coffee districts, and as capitalists had full confidence in the success of planting, estates multiplied and extended their acreage very rapidly. Throughout 1860 and 1861, there was a perfect mania for planting, extravagant ideas of the profits to be reaped from it having taken possession of the public mind, while such contingencies as bad seasons, appear to have been entirely forgotten. Men of moderate means joined in buying land and invested their hard-won savings without a doubt as to success, while others of greater ambition established Joint Stock Companies, spent lakhs in the purchase of ready-made estates, and pleased their own minds and those of the other shareholders, with visions of fifty or sixty per cent. of profit. As might have been foreseen, such extravagant hopes have never been realised, the anticipated fortunes having retreated far away into the future, and the fifty or sixty per cent. dwindled down to five or six. In many cases, indeed, these adventures have, from various causes, proved complete failures, the balance always being on the wrong side; and taking them as a whole, the results have been such as to render the public distrustful of coffee culture

as a safe or profitable investment, and to lower greatly the value of estates.

Mysore:—The success of Mr. Cannon's experiment gradually induced others to follow in his footsteps, the fine old estates of Igoor and Hulhully being the next in succession as regards age in the Mysore territory. Around them as centres others have, within the last twelve or fifteen years, rapidly sprung up, until at the present day there is nearly a continuous chain of estates from the northern slopes of the Bababoodens, to the southern limit of Munzerabad.

The coffee districts in Mysore lie in the Nuggur and Astragam Divisions. There are also a few holdings in the Nundidroog Division, but so small, that they do not require any notice here. As regards Nuggur, the coffee-producing districts are two in number, viz., Shemoga and Cuddoor. The extent of land taken up for its culture in the former is not exactly known, but the following statement of the exports of coffee from the district, during the last eleven years, shows how rapid the development of this branch of industry has been; the produce last season having been more than ten times what it was in 1857-58:—

Exports of Coffee from the Shemoga District, from 1857-58 *to* 1867-68.

Years.	Coffee.			
	Candies.	Maunds.	Seers.	Tolahs.
1857-58	30	3	35	0
1858-59	48	7	25	0
1859-60	125	12	23	0
1860-61	177	10	18	0
1861-62	159	18	39	0
1862-63	297	9	1	14
1863-64	208	6	10	10
1864-65	409	6	24	16
1865-66	222	3	0	10
1866-67	52	19	17	6
1867-68	336	9	23	18

In *Cuddoor*, 7,302 acres have been secured by Europeans, and 74,674 acres by Natives for coffee planting, but the export returns do not show the remarkable increase in the produce observable in the Shemoga return. On the contrary, it is so uniform, the fluctuations that appear being nothing more than what might be occa-

sioned by differences in seasons, that we may infer, that coffee culture in this district has been nearly stationary for the last ten years:—

Exports of Coffee from the Cuddoor District, from 1858-59 *to* 1867-68.

Years.	Coffee.		
	Maunds.	Seers.	Tolahs.
1858-59	1,37,889	6	0
1859-60	2,21,803	13	8
1860-61	1,80,557	23	12
1861-62	1,83,781	2	0
1862-63	2,45,754	11	0
1863-64	2,73,358	26	0
1864-65	2,20,147	7	9
1865-66	2,45,989	15	19
1866-67	55,292	18	0
1867-68	2,39,628	7	5

In both statements the effects of the bad season of 1866-67 are very noticeable; but the large returns in the following year show that the depression was only temporary, and that very many trees were not destroyed by the Borer. In Munzerabad, situated in the Astragam District, there is a greater extent of land in the hands of Europeans, the amount being 22,385 acres, while Native proprietors hold 28,351 acres. The whole of this is not under cultivation, but we may fairly assume that about three-fourths of the entire area have been reclaimed. The following table gives the weight of coffee exported, during the last nine years, and shows that the culture has gradually been increasing:—

Exports of Coffee from the Munzerabad District, from 1858-59 *to* 1866-67.

Years.	Coffee.	Years.	Coffee.
	Maunds.		Maunds.
1858-59	38,954	1863-64	1,59,834
1859-60	63,444	1864-65	1,42,365
1860-61	91,458	1865-66	1,60,184
1861-62	84,580	1866-67	1,16,580
1862-63	1,21,534		

The revenue from coffee land in Mysore is derived from a duty of one-fourth of a rupee on each maund (28 lbs.) of produce, so that

the State, as well as the cultivator gains by good, and loses by bad seasons. A good deal might be said in favour of a change to the acreage assessment; but on the other hand, the existing system seems to answer on the whole very well, and is certainly very acceptable to the planters.

Coorg :—In Coorg, lying immediately to the south of Munzerabad, coffee was introduced in the days of the Rajahs by a Mahommedan fakeer, who is said by some to have brought the seed from the Bababoodens, and by others from Mocha. However this may be, there can be no doubt that the plant has been cultivated there in native gardens for more than fifty years, and there are small native holdings near the Nalkanad Palace, in which the plants are from twenty to twenty-five years old. About twelve or thirteen years ago, European planters began to enter the province, and, during the last eight years, their number has rapidly increased. At the same time the natives of Coorg, prompted by their example, have eagerly embarked in coffee culture, and now even every spare bit of ground about their cottages is stocked with the plant. At present, 47,572 acres are held by Europeans, and 24,638 acres by Natives as coffee land, but as the rules for assessment do not make any distinction between cultivated and uncultivated, it is impossible to say how much has actually been planted. Probably 40,000 acres would be quite within the mark. Formerly, as in Mysore, the revenue from coffee culture in Coorg was levied by a tax on the produce; but four years ago, on the petition of the planters, an acreage assessment was substituted for the old system. Under this, during the first four years of tenure, the land is held free, but thereafter, up to nine years, there is an annual tax of 1 Rupee per acre, and subsequently a tax of 2 Rupees per acre in perpetuity. All land taken up for coffee, no matter whether cultivated or not, is subject to these conditions, and there can be no doubt that this system prevents speculators from acquiring jungle with the view of selling it in after-years at a profit, and stimulates planters to cultivate their land carefully in order to render it as profitable as possible.

The following Statement exhibits the number of maunds of coffee exported from Coorg during the last eleven years, and, judging from that, it will be observed that the cultivation has extended very rapidly during that period. In the season 1857-58, the total exports only amounted to 46,336 maunds, while ten years after they reached 260,000 maunds, or more than five times as much; and it

must be recollected that even yet a great many estates have not come into full bearing :—

Statement of Exports of Coffee from Coorg, from 1857-58 *to* 1867-68.

Years.	Coffee.	Years.	Coffee.
	Maunds.		Maunds.
1857-58	46,336	1863-64	2,34,182
1858-59	66,862	1864-65	2,40,000
1859-60	1,11,768	1865-66	2,50,000
1860-61	1,28,412	1866-67	2,60,000
1861-62	1,53,781	1867-68	2,40,000
1862-63	1,40,113		

Wynaad and Neilgherries :—Coffee has been cultivated on the slopes of the Neilgherries for about thirty years. The extent of land suited for the purpose is rather limited, and there is no probability of the acreage now under culture being greatly increased. Many years ago Dr. Gardner gave it as his opinion that the eastern flank of the chain would, owing to the dry nature of the climate, be found unsuited for coffee culture, and certainly experiments on that aspect have not, as a whole, been very successful. One or two estates have no doubt been very productive, but they have been made so at an enormous expense, and taking everything into account, have not probably been very remunerative. On the western face of the chain, the monsoon beats with such violence that it would be quite useless to attempt the culture of coffee on that side.

Coffee and Tea plants were introduced into Wynaad about forty years ago by a Major Bevan, who commanded the Wynaad Rangers. He did not take up the cultivation to any extent, but merely put down some plants by way of experiment in a garden at Manantoddy. These throve remarkably well, and having been seen by a Mr. Glasson in 1838, induced him to think of planting on a larger scale. Accordingly, in 1840, he began operations and opened out on a hill in Manantoddy the first estate in Wynaad. In 1842, Mr. King, Agent for Messrs. Parry and Company, Mr. Baber, a retired Bombay Civilian, the Messrs. Morris, Captain Pope, Dr. Magrath, and several others entered the district. Nearly all the land taken up at this period was what is known as *grass, or bamboo land,* and in consequence most of the estates proved unprofitable, and of many of them not a trace—save the ruins of bungalows—remains at the

present day. After a few years those pioneers who had come in with such high hopes began to leave, and by 1850 only Mr. Glasson and Messrs. Parry and Company's Agent remained in the district. They had by this time moved into South Wynaad, and it must have required no little courage to hold on, when thus deserted by neighbours, in a wild district almost totally unprovided with roads, and containing no villages from which sufficient supplies could be obtained. For some years after this crisis, coffee culture made very little progress in Wynaad; but about 1855, a second rush to the district began, and the new arrivals seem to have vied with each other as to who would acquire most land, and open it out the fastest. Apparently there was in some cases at this period a good deal of injudicious haste manifested in the selection of land, and this, coupled with the ignorance of the new comers regarding the soil and climate of Wynaad, led to many of the estates proving absolute failures. Between 1855 and 1865, the acreage under culture was rapidly extended, but since the latter date, owing to the alarm about the Borer, there has been comparatively little increase. In reviewing the whole history of coffee culture in Wynaad, it is very remarkable how little heed one man has taken of the mistakes of another, and hence we find hopeless experiments repeated over and over again. According to returns received from the local authorities, there are 29,909·08 acres under coffee in Wynaad, of which 21,479·54 acres are held by Europeans, and 8,429·54 acres held by Natives. The small area owned by the latter class is very remarkable, as compared with what is held by them in the other districts. I have not been able to get a return of the actual amount of coffee exported annually from Wynaad, but the following table, which gives the quantities shipped on the Malabar Coast during the past twelve years, must contain nearly the whole of the crops, as very little would pass out by Mysore and Coimbatore :—

Statement showing the amount in Cwts. of Coffee grown in Wynaad, exported from the Ports of Malabar.

Years.	Coffee.	Years.	Coffee.
	Cwts.		Cwts.
1856-57	32,658	1862-63	43,907
1857-58	20,416	1863-64	91,947
1858-59	36,934	1864-65	110,548
1859-60	49,680	1865-66	125,891
1860-61	48,742	1866-67	66,552
1861-62	91,080	1867-68	128,021

Of late years coffee culture has also been begun on the Travancore Hills, which in climate and other natural advantages seem greatly to resemble the coffee districts in Ceylon. The Pulney Hills in Madura are also said to offer suitable sites for estates, but, judging from their position and botanical peculiarities, the dry season will probably prove too trying to permit of the plants being profitably cultivated.

General Remarks:—It will thus be seen that coffee estates extend in nearly unbroken chain along the crests and slopes of the Ghats, from the northern limit of Mysore, down to Cape Comorin. Hill sides and ravines, but lately the favourite haunts of the elephant and bison, have been stript of their covering of grand old forest, and vast solitudes converted into scenes of busy industry; and wherever the planter has gone, there is gradually following in his track a net-work of imperial roads, along which hamlets and villages are springing into existence, so that in a few years these once pathless jungles will be quite accessible and possessed of a considerable population. The benefits that will flow from this influx of European enterprise and capital must, ultimately, be very great. Every estate opened up may be regarded as a fresh centre of civilisation, a new source of revenue, and additional means of livelihood for the labouring classes. At the same time it must be recollected that coffee culture is still, so to speak, but in its infancy in Southern India; that many planters have had little or no previous experience in their occupation; that they have had to contend with various difficulties inseparable from the early days of all such undertakings, and that, therefore, we cannot expect, under the most favourable circumstances, the full tide of success and resulting advantages to set in for several years to come. In Mysore and Coorg there are from 130 to 150 Europeans, and in Wynaad about the same number engaged in coffee culture. The capital embarked is something enormous, every acre costing, on an average, about £30 before it can be brought into bearing. In Mysore and Coorg there are probably over 100,000 acres under coffee, and if we reduce the cost of reclaiming to £12 per acre, so as to make allowance for native holdings which are generally opened out on a cheap scale, we shall have property representing a money value or expenditure of £1,200,000 sterling. In Wynaad, the exact acreage is 29,909·08, or say in round numbers 30,000; then allowing £20 per acre for opening, as the native holdings are small, and almost all the land

cleared, we have property in Wynaad which has cost the owners £600,000 in preliminary expenses. There has thus altogether been expended in opening estates in these districts capital to the extent of £1,800,000, and it is to be hoped, both for the sake of the enterprising men who have placed so much at stake, and that of the country, that coffee culture will ere long prove more remunerative than it has hitherto done. Of late, the other great coffee producing countries, Ceylon, Java, and Brazil, have year by year been increasing their exports of this article, and this, coupled with a prospective increase in the working expenses, has led many Indian planters to fear such an ultimate reduction of prices, as would render its culture in this country unprofitable. In 1860, the coffee produced in Brazil amounted to 2,956,250 cwts., but in 1863-64, owing to various causes, it had dwindled down to 2,167,000 cwts. Next season showed a decided increase, the out-turn having reached 3,000,000 cwts., and in 1866-67, it amounted to no less than 3,799,647 cwts. It thus appears that coffee culture is rapidly increasing in this quarter of the world, and, although hampered by various obstacles, still so favourable are the climate and soil, and so great the facilities for exportation provided by the recently made railway, that it is certain to go on with steady progress, and Brazil continue the greatest coffee-producing country in the world. At the same time there does not appear to be any immediate risk of her competing extensively with the coffee countries of the East in the European markets, as her neighbours, the United States, buy a very large portion of her crops. In 1867, of 2,659,753 bags exported, no less than 1,226,636 went to American ports, and the consumption of coffee throughout the republican territory is steadily on the increase.*

Java, the next largest coffee-producing country in the world, is a less formidable rival, her exports having remained nearly stationary for a considerable period. The following table exhibits the amount of the coffee crops in Java throughout a series of years :—

Years.	Coffee. Cwts.
1862-63	1,474,000
1863-64	671,000
1864-65†	1,271,000
1866-67	1,162,596

* These statistics have been got from Ferguson's "Ceylon Directory."
† Statistics for 1865-66 not known.

In Ceylon the annual increase in crop has of late been considerable, as will be seen from the following table :—

Years.	Coffee. Cwts.
1860	635,000
1861	613,000
1862	600,000
1863	807,000
1864	656,000
1865	927,000
1866	900,000
1867	945,000

The energy and intelligence, too, with which coffee culture is conducted in Ceylon, lead us to anticipate a still further increase in production ; but on the other hand, as the acreage of unopened land is not very extensive, the day cannot be far distant when it will have reached its maximum.

The tables already given show how coffee production has progressed in our own coffee districts, and the following statistics of exports from the East and West Coasts exhibit the total produce of Southern India, throughout a series of years :—

Years.	Exports from			Total.
	South Canara Ports.	Malabar Ports.	Madras Ports.	
	Cwts.	Cwts.	Cwts.	Cwts.
1857-58	34,600	34,781	2,284	71,665
1858-59	36,587	56,203	9,750	102,540
1859-60	53,463	67,502	16,598	137,563
1860-61	82,448	73,915	34,475	190,838
1861-62	58,700	108,332	22,487	189,519
1862-63	75,819	80,385	15,068	171,272
1863-64	77,499	118,906	51,810	248,215
1864-65	58,827	121,681	80,498	261,006
1865-66	74,155	139,983	80,174	294,312
1866-67	69,608	85,646	52,627	207,881

Although coffee culture is thus extending in every country in which it is conducted, still there is no reason to expect a very great reduction of price, in consequence, as the consumption of the beverage is rapidly increasing both in the east and the west. At the

same time the Indian planter must strain every nerve to keep his place in the field, and there is no doubt that this end will be best accomplished, by adopting a more careful and scientific system of culture. On the part of Government all that is required is a continuation of the present expenditure on the making of roads in the coffee districts, and the extension of railway communication as soon as that can be effected. The success and development of coffee culture depend also very largely on the supply of labour, and at present this, in most districts, is both uncertain and inadequate. Mysore is perhaps better off in this respect than the other districts, as the coolies generally belong to villages near the estates, and the average rate of pay is lower than in Coorg and Wynaad. In the latter districts, the coolies are chiefly drawn from the interior of Mysore, and from below the Ghats. To induce them to take employment, it is found necessary to give advances, a system productive of considerable loss to the planter, as desertion is very common, and it is found practically almost impossible to lay hold of a deserter. As a rule, too, the coolies will only work for eight or nine months of the year, and unfortunately the season at which they choose to go away, is the very time when pruning and other important operations should be going on. The existing labour law seems, as a rule, to be approved of generally by planters, but it appears desirable that some modification should be made in it, so as to render an engagement or contract binding without the tender of a money advance. At present, too, in some districts, the difficulty of bringing a culprit to justice is so great, and the prosecution so tedious, that many planters prefer losing their money and labour to going into Court.

II.—CLIMATE, SOIL, AND ELEVATION REQUIRED FOR COFFEE CULTURE.

Of all exotics cultivated in India, coffee is certainly the hardiest, as it may be seen growing at every elevation, from that of the sea level, up nearly to the crests of the Neilgherries, and, of course, under the most different conditions, as to moisture, soil, and temperature. At the same time it thrives best in a moderately warm and moist atmosphere, such as is to be found at a medium height on tropical hill ranges, dry heat or great cold being equally unfavourable for

it. When grown at a low elevation, it suffers from the drought and high temperature of the hot season, and although irrigation and shade may partly avert the ill effects, still coffee cannot be profitably cultivated in Southern India at any elevation much below 2,000 feet above the sea level. Again, in too elevated localities it runs to leaf, and produces but little fruit, and that, owing to the low temperature and want of sunshine at the proper season, but rarely arrives at maturity. A site where the temperature ranges from 60° to 85°, and the rain-fall is copious and well distributed, while the air and soil are perennially moist, will be found the best suited for coffee. Such a spot will generally be met with at an elevation varying from two to four thousand feet, a good deal depending on exposure and position as regards the crest of the range. Thus a station on the western slope of the Ghats may have a rainfall double that of one at the same height on the eastern flank, and a place eight or ten miles distant from the crest of the chain, will have far less rain than one nearer that point. The exposure is also of great importance—slopes facing the south or south-west being much hotter than those looking north or north-east. Under any circumstances, land with a due south-west exposure is not suited for coffee, the violence of the monsoon rendering the plants unproductive, or killing them outright. Slopes having a northerly or easterly exposure are undoubtedly the best, and they should be covered with forest, as coffee will not grow on grass-land, or ground covered with scrub jungle. The degree of slope is also a matter of great importance, for when the declivity is too great, the storm water, in spite of every precaution, is sure to carry off much of the most valuable portion of the soil. It is well to avoid the crests of high ridges or low hills, as the plant does not generally thrive on these, and forest left standing in such places affords shelter and feeds springs. The land in the coffee districts is conveniently divided by planters into *Forest* and *Bamboo*.* The former lies near the crest of the Ghats, and in a state of nature is covered with dense tall forest, while the latter is situated more to the east, and is clothed with rather open jungle, characterised by numerous clumps of bamboo. As to the relative merits of these two tracts for coffee culture, some difference of opinion prevails, but my own observations have led to the conclusions, that as regards climate, *forest-land* has the advan-

* See Map, where the line that separates these is indicated by a yellow streak.

tage—the air being moister, and the temperature lower and more equable—while in the matter of soil, *bamboo-land* is decidedly the superior. It must, however, be remarked that the bamboo district is, during the dry season, swept by scorching east winds which sometimes cause the coffee to lose its leaves, and even kill the young wood, and is liable to suffer from severe and protracted droughts. There is a pretty general belief that on estates in the bamboo district, coffee will live only for eight or ten years, and experience apparently confirms this opinion. The fact is, that the peculiarities of the soil and climate there cause the plants to be prematurely and unusually productive, by which they are speedily exhausted ; but, I have no doubt, that by judicious pruning, protection with shade, and manuring, they might be rendered just as enduring as those in other localities. The annual rain-fall is a point which requires to be carefully considered in selecting a site for a coffee estate, as excessive rain is nearly as prejudicial to the plant as excessive drought. Unfortunately, too, a heavy rain-fall by no means ensures perennial humidity of the soil and air, for in many parts of the coffee districts, where upwards of 100 inches are deposited during the south-west monsoon, there is a dry season quite as trying as that of eastern Mysore or of Coimbatore. A fall of from 80 to 100 inches is all that is necessary, provided a fair proportion of it descends in February, March, April, and May, so as to temper the severity of the heat during these months. The year in our coffee districts may be divided into the *dry* and *wet seasons*, and in most cases these are characterised by extremes, the former being excessively hot and dry, while during the latter, torrents of rain come down and the air and earth are saturated with moisture. These peculiarities prove very trying to the coffee, and have been the chief agents in rendering some estates unsuccessful. To enable the plant to withstand such inimical agencies must, of course, be the chief aim of the planter, and to secure this end, the best means will be judicious draining to remove the superabundant water during the rains, with manuring, and in many cases shading, to aid the plant in resisting the depressing influences of the dry season. The next point of importance is the nature of the soil and subsoil. In nearly all our coffee districts the great want in the soil is lime, but it generally contains a fair amount of potash and soda, derived from decayed wood ashes, and the debris of the metamorphic rocks, which abound everywhere. The soil best suited for coffee is a chocolate coloured

loam, resting on a moderately porous subsoil. Such soil is very common in some districts, and often of great depth. Some red and blackish soils also answer very well, the former consisting of clay coloured with iron, sand, and organic matter, and the latter chiefly of humus and sand. There is a black soil, with a strong resemblance to "cotton soil," which cakes and cracks during the hot season, in which coffee does not thrive well. In some districts laterite is the prevailing subsoil, and when not too stiff and too near the surface, it does not appear to do any harm, but when the soil is thin, so that the roots enter the laterite, the plants shortly begin to look sickly. As a rule too, laterite districts when stript of their vegetation, are very hot, and rather feverish. Light sandy or gravelly soil does not suit coffee, being poor, hungry, and too dry. Stiff clay soils are equally unsuitable; but, perhaps, the finest coffee in India is raised on a soil consisting of a drab coloured rather porous clay. In wet weather a stiff clay soil does not permit the water to percolate through it, and the plants are, therefore, liable to suffer from rot at the root; and again in the dry season, although it may contain a large per-centage of moisture, it cakes on the surface, and so obstructs the functions of the roots. A moderate amount of stones or boulder masses is by no means objectionable, as it prevents the earth from being washed away, and also renders it cooler and more permeable to moisture. Soil resting immediately on rock, that is, without a considerable depth of intervening subsoil, is apt to suffer from drought, and the plants turn sickly or die on touching the rock. The colour of a soil is of considerable importance, that of a dark colour being heated most, and pale clay the least by the solar rays. The degree of moisture, however, greatly affects the temperature of soil, and so it often happens that humus, which has a great affinity for water, is considerably cooler than a soil of lighter colour. The power that a soil has of absorbing and transmitting, as also its capacity for retaining water, are points of much importance; its fertility being in direct proportion to the degree of porosity and its capacity for receiving and husbanding moisture. The earth that seems to possess these qualities in the highest degree is a loam, such as that which has been described as the best suited for coffee, viz., a chocolate coloured friable mixture of sand, clay, and organic matter. Plants are, perhaps, the safest guides as to the nature and fertility of a soil, and the planter recognises this in practice by avoiding grass-land and sparse jungle, and selecting a

site covered with dense forest. In short, it may be regarded as a safe maxim, *that land covered with dense jungle has in general a soil suited for coffee culture.* At the same time a block should never be selected, until the nature of the soil and subsoil has been carefully ascertained by sinking pits in various directions. Before leaving this subject, I cannot help remarking, that if greater care and judgment had been exercised in the selection of sites for estates, coffee planting would have been very much more successful than it has hitherto proved. Indeed, mistakes in this matter were quite inevitable, as, in numerous instances, the men who went site hunting were almost, or totally inexperienced in coffee planting. The loss and mischief too resulting from such errors have unfortunately not descended on the owners of the property alone, inasmuch as they have rendered capitalists distrustful regarding the stability of coffee estates in general, and so turned into other channels a great deal of money, which might otherwise have been employed in extending coffee culture. The unnecessary destruction of forest too, that these futile experiments have led to, is a matter of serious concern to the State, for the denudation has rendered the climate both drier and hotter, and the scrub jungle that springs up on abandoned clearings is a fertile source of malaria. It seems, therefore, desirable with a view to check such unnecessary felling, that, in future, when application is made for coffee land, the chief Revenue Officer and Executive Engineer of the district, along with the Conservator of Forests, should inspect the block selected, and ascertain whether or not it is suited for the purpose.

III.—SKETCH OF THE PHYSICAL GEOGRAPHY OF THE COFFEE DISTRICTS IN SOUTHERN INDIA, WITH REFERENCE TO COFFEE CULTURE; INCLUDING EFFECTS OF FOREST DESTRUCTION.

The tract or zone* in which coffee is cultivated in Southern India stretches chiefly along the crests of the Western Ghats, and extends from about the 14° of North latitude down nearly to Cape Comorin. The kind of climate that the plant requires, and the limited breadth of the range prevent the zone from even attaining any great breadth, and the former reason also causes it to follow

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* See Map.

exactly all the windings of the chain. In this sketch it will be convenient to adopt the ordinary division of the tract into the coffee districts of—

Mysore { Nuggur and Munzerabad.

Coorg.

Wynaad.

Mysore:—In Nuggur, the most northerly part of the Mysore zone, the coffee district is peculiar, the estates being mostly situated on the slopes of the Bababoodens, and other hills belonging rather to the table-land of Mysore than the Ghat range. The eastern face of the Bababoodens is very abrupt, and is crowned throughout the greater part of its length with a bold lofty scarp like the ruined battlement of some ancient fort. From the base of this a steep slope, covered with soil, resulting chiefly from the debris of the overhanging rocks, runs down to the table-land, and is covered with a moderately open and tall forest, in the shade of which the coffee is cultivated. The range is of a semi-circular shape, the convex face looking eastwards, and on the other side there is a vast basin with steep grassy slopes, intersected in the most picturesque manner with wooded ravines, in which coffee has long been cultivated by natives. On the south-east side of the hollow is the village near which coffee was first planted in Southern India. The top of the range, with the exception of a few sholas, is entirely covered with a carpet of grass, which in the rains is variegated with ground orchids, the splendid orobanche, and blue and white violets. The mean elevation of the Bababoodens is about 5,000 feet, and the rocks are chiefly micaschist and gneiss, the layers of which are flexured and contorted in the most curious manner. Magnetic iron ore occurs near the village just mentioned. Wastara and Coppadroog, in which coffee culture is also carried on, are mountainous districts to the west and south-west of the Bababoodens, lying mostly between them and the axis of the Ghat chain. The rain-fall on the western side of the Bababoodens and districts beyond is heavy, but on the eastern slopes it rarely exceeds forty inches. Notwithstanding this, estates in the latter situation seem to do very well, the soil being rich and naturally moist, while the elevation at which they are placed gives them a comparatively cool temperature, and the forest shade protects from the sun and scorching winds. There is still a

good deal of land suitable for coffee culture existing in Nuggur, but mostly in remote parts of the district, and far away from public roads. Cannon's old and famous estates lie close to the south-west end of the Baba-boodens. The rain-fall is deposited almost entirely during the south-west monsoon, and the dry season is long and severe, in consequence of which shade is absolutely necessary for coffee. In the localities in which estates are situated, the forest is not so dense or lofty as that which grows near the axis of the Ghat chain, but of moderate height and evergreen, or at any rate bearing leaves during the hot season, and, therefore, well adapted for shade. In most of the valleys, and at low elevations, dense bamboo jungle, interspersed with teak, blackwood, mutti, and other deciduous trees, which lose their leaves in the dry season, prevail. Such tracts are quite unsuited for coffee culture. The grains chiefly cultivated are ragee and rice; and the most abundant fruits are the plantain, orange, and wild mango. There is a small Government plantation of the *Chinchona succirubra* at Kulhutty, on the Bababoodens, doing well; but no sites, very suitable for tea culture, seem to exist. The coffee produced in the district is generally of very superior quality and flavour, and that from Cannon's estates is as highly prized, and fetches as good a price in the English market as the Mocha bean.

Munzerabad:—This district, which lies immediately to the south of Nuggur, differs considerably from it in various respects. It consists of a succession of low rounded hills, usually covered with grass and studded with clumps of trees, which give it very much the appearance of an English park on a large scale. Between the hills run beautiful winding valleys or ravines, either under rice, or covered with open evergreen forest, which here and there runs up the grassy slopes in dark green promontories. To the west of the rounded hills the Ghats culminate in bold isolated mountain masses, between which ravines and passes of the grandest description run down to the low country. The prevailing rock is gneiss, and lateritic formations are very common. The surface soil on the grass-covered hills is generally loam or clay of a bright red colour, and in the rice flats the soil is mostly a strong clay of a drab colour. Some of the rounded hills, so characteristic of the district, are covered with forest, under which the coffee is cultivated. The soil in such places is generally a dark loam of variable depth, resting on a red gravelly subsoil, or friable half-decayed gneiss. On the grassy hills a stemless *Date* palm and the *Bracken* fern are very

common, while in the rice valleys the *Screw-pine, Melastomads,* and a few hardy ferns abound. The forest near the axis of the chain is very dense and lofty, but the tract covered by it offers few sites fit for coffee culture, the rain-fall being too heavy and the monsoon much too violent. Most of the estates in the district are situated towards its eastern frontier, on some of the forest-clad hills or ravines already described. The trees in such situations are of medium size, not too dense, and evergreen, so that when the underwood has been cleared away, the forest becomes admirably suited for shade culture. On the outskirts of some of these forest patches, considerable tracts of a sparse jungle, containing many deciduous trees exist, indicating at once a low degree of humidity and a high temperature. Land covered with such wood is quite unsuited for coffee. Here, as in Nuggur, the rain descends chiefly between the first of June and the end of October, and the total annual amount in the coffee zone ranges from a little over one hundred inches on its western, to forty or fifty on its eastern margin, as will be seen from diagram No. 1. The dry season is very long and trying, the showers that fall between November and March being few, light, and uncertain. Shade is therefore absolutely necessary to protect the coffee during that period, all attempts to cultivate it in open ground having proved partial or complete failures. The general elevation of Munzerabad is rather low, the average height being about 2,800 feet, and this also increases the sun's power. There is now very little good coffee land belonging to Government in the district, nearly the whole of it having been secured by European and Native planters. The general crops and food of the people are rice and ragee. The coffee exported is known in the English market as *Mysore,* and generally brings prices rather above the average of Indian plantation.

Coorg :—This district is the most southerly portion of the coffee zone under the Commissioner of Mysore, and is remarkable for the grandeur and beauty of its scenery. From whatever direction it is approached, it presents a mass of blue hills of bold outline, and nature has defined its limits by bold mountain steeps and impenetrable forests. These in former years proved formidable defences, but it is now traversed by lines of excellent roads passable at all seasons, which connect it with the adjoining districts. Entering by any of these the traveller from the plains is struck with the grandeur of the forests, which in great living walls line both sides of the

road. Huge climbers scale the trees, gorgeous orchids cluster on their branches, and the scarps of the road are covered with mosses and ferns in great profusion. Mercara, the capital of Coorg, is very centrically situated, and has been built on one of the highest and healthiest spots in the province. It stands on a plateau about 3,500 feet above the sea, and is surrounded by a number of small rounded hills, from which the forest has been completely cleared away to make room for coffee, which has, however, in most instances died out, leaving the denuded tracts unsightly in the extreme. Looking southwards from Mercara, the whole of Southern Coorg can be seen at a glance, and a more splendid sight could hardly be imagined. It is a vast undulating tract, with here and there a low hill standing up, and is bounded on the west by a mountain chain, the axis of the Ghats, of great elevation and bold rugged outline, and to the south by the grand Brummagherry range. From such a point of view Southern Coorg appears to be covered with one unbroken undulating sheet of forest, but a closer inspection discovers numerous intersecting deep-set winding valleys under rice. There are also many grassy glades, producing park-like scenes, in which nature far outstrips the most skilful efforts of the landscape gardener. The average elevation of Southern Coorg is about 2,800 feet, and most of the forest tracts in it suitable for coffee have been cleared away, except in the large catchment basin of the Cauvery, where the land is almost entirely in the hands of Coorgs. Here, coffee is chiefly cultivated under shade, and although the owners were willing to part with their property, which they are not, felling has been strictly prohibited by Government. To the north of Mercara the country is much wilder, presenting a vast panorama of rugged rocky mountains, with great scarps of bare rock, and disposed in the most irregular manner. The valleys between these are very deep, uneven, and rocky, and, therefore, not so well adapted for rice cultivation as those in Southern Coorg. All the hills of Coorg have the wild picturesque aspect that belongs to those of primary districts. The prevailing rock is gneiss, varying in colour and composition, and in all stages of decay. Quartz in beds or isolated pieces is rare, but boulders of gneiss, agreeing in character with the subjacent rock, are common. Kaolin in extensive beds is abundant, more especially about Mercara. Talc slate, and mica schists also occur in some places, but only to a limited extent, but laterite is to be met with here and there throughout

the whole province, and is the prevailing subsoil in Southern Coorg. Coffee culture in Coorg was at first chiefly carried on in the dense jungle tract, but of late years numerous estates have sprung up in the bamboo jungles of the southern portion of the province. Most of the older estates surround Mercara within a radius of eight or ten miles, a good many being on the hilly plateau on which the station stands, and the remainder on the sides of the Sumpajee Ghat, a magnificent pass traversed by the Mangalore road. In the former situation the monsoon rages with great fury, and wherever the land is fully exposed to its violence, the coffee has either partly died out, or remains small and unproductive. When the exposure is favourable, or shelter afforded by standing forest, the results have been more satisfactory, some estates having yielded very good crops. The quality of the soil varies greatly, but it is generally of a reddish or chocolate colour, open and of fair quality. The subsoil is usually a red gravel, clay, or decaying rock. In the Sumpajee Pass and various other quarters, although the land is of fair quality, it is so steep, that it is liable to suffer heavily from wash. The rain-fall around Mercara is very heavy, the mean of three years being 143·35 inches. It, however, rapidly decreases as we proceed eastwards, and at a distance of six miles down the Fraserpett road it does not probably, on an average, exceed seventy or eighty inches. A few large estates are situated in this direction, and nearly all of them have suffered severely from the droughts of recent years; the intensity of which has been greatly aggravated by the extensive clearings. Indeed, the dry season is so long and severe in this quarter of the province, that shade is absolutely necessary to protect the coffee from its effects. In South Coorg the heavy jungle tract approaches close to Veerajpettah, and immense clearings have been made to the west and south-west of the village. All the estates to the west lie on the hilly plateau of South Coorg, and the total destruction of forest, within a radius of eight to ten miles, exceeds three thousand acres. The estates to the south-west are situated on the slopes of the Perriambady Ghat, and on the flanks of hills to the south-east of it, and to make way for them an area of fully 1,800 acres, covered with splendid forest, has been completely denuded. Such wholesale clearing has had a most disastrous effect on the local climate, and there is no doubt that it caused the droughts of recent years to tell on the district with tenfold force. The soil in this quarter is chiefly a brownish or reddish shallow sandy loam. For the most part it rests

on a subsoil of laterite, which, as already stated, makes land easily heated when deprived of its forest covering, and renders it unsuitable for coffee when it approaches too near the surface. In the Perriambady Ghat the soil contains a large proportion of clay, much coarse gravel, and in some places so many large boulders that planting is rather difficult. Both here and to the west of Veerajpettah the land is often very steep, and the usual effects have resulted from the wash of the monsoon. The prevailing rock is a dark syenitic-like gneiss. Hardly any unappropriated land suitable for coffee remains in this quarter, except a few blocks belonging to Coorgs, immediately to the east of Mount Remarkable. About ten miles to the east of Veerajpettah lies the village of Seedapoor in the bamboo district, and to the west and east of this a great many estates have sprung up on the slopes of low hills. These were mostly covered with heavy forest, but of quite a different character from that found near the crest of the chain. Generally speaking the land in this quarter is moderately level, and the soil a rich loam of great depth. Close to Seedapoor, the famous Mission Estate, which for years in succession yielded a ton of coffee per acre, existed, but has been completely destroyed by drought and the ravages of the Borer. Weeds grow much more abundantly and rapidly, and are much more difficult to subdue in this than in the heavy jungle tract. As soon as the monsoon sets in, grasses, some of them with nearly indestructible under-ground stems, spring up in perplexing abundance, and when they have been cleared away, the Goat-weed (Ageratum Cordifolium) takes possession of the ground.* The annual rain about Seedapoor does not

* Professor Leibeg gives the following analysis of the ash of the Goat-weed. He says it robs the soil of the very constituents indispensable for coffee, and recommends that it should be gathered, burned, and the ashes returned to the land as manure :—

It contains in 100 parts

Potash	28·77	
Soda	6·89	
Lime	15·58	
Magnesia	10·62	
Phosphoric Acid	3·44	
Silica	7·04	
Sulphuric Acid	4·07	
Chlorine	6·07	
Carbonic Acid	16·01	
Oxides of iron	3·28	
		101·77
Deduct Oxygen		1·36
		100·41

usually exceed sixty inches, and it falls chiefly during the south-west monsoon. From December to April the air is very dry, the temperature high, and the sun scorching. At this period the forest trees lose their leaves, and herbacious plants are withered up or lead a precarious existence. During the first few years coffee grows here with amazing rapidity, and produces crops much beyond the average yield, in consequence of which it speedily gets exhausted, and is apt to suffer from Borer, and die out in from eight to ten years. Shade is, therefore, necessary, and as the original forest is not fit for that purpose, the planter must encourage the spontaneous growth of suitable trees, and put down seedlings of such when nature does not come to his aid. The diagram No. 2, prepared from tables in "Dove's Klimatologische Beetrage, 1857" will afford the requisite information as to the climate of Coorg in the heavy jungle tract, and to render it still more valuable the rain-fall and humidity of the air at Kandy in Ceylon, around which coffee has been so successfully cultivated, have been introduced to permit of comparison. From this it will be observed that although the rain-fall at Kandy is less than at Mercara, it is much more equably distributed throughout the year, and, therefore, more favourable for vegetation. In Coorg, the bulk of the rain comes down during June, July, August, and September, as much as forty or fifty inches being deposited during the first named month. Throughout the rainy season both the air and earth are saturated with moisture, and the coffee in consequence getting gorged with fluid, the circulation and other functions are performed very imperfectly. During the remaining eight months of the year it is stimulated by a high temperature and bright sunshine, while the rate of humidity is very low, in fact too often below the per-centage necessary to keep the plant in a healthy condition. It will be observed that as regards the humidity of the atmosphere, there is, taking the whole year round, a larger per-centage and greater uniformity in Ceylon than in Coorg, and this is no doubt in a great measure the result of its insular position. The monthly and seasonal means show, that the temperature is remarkably equable at Mercara.

Tea is being tried in the province and grows well, but it has yet to be seen whether it will yield an amount and quality of leaf, such as will render its cultivation profitable. There is a small Government plantation of the Chinchona succirubra, but that, too, is merely in the stage of experiment. Coorg is famous for a species

of orange, a small reddish yellow fruit with a loose skin, and pulp of great sweetness and delicious flavour. The other fruits most commonly seen are the plantain and guava, a species of the former being indigenous. The tamarind, owing to the excessive rain-fall and low temperature, will not grow. Rice is the principal crop, and the paddy-fields are entirely watered by perennial streams.

Wynaad:—This district stretches in a south-east direction from the southern frontier of Coorg, down to the northern flank of the Neilgherry range. Its extreme length, as the crow flies, from Peria to Goodaloor is about fifty-five miles, and it has an average breadth of about twenty miles. Its south-west frontier is bounded by a range of bold hills, some of which attain an elevation of nearly 6,000 feet. To the east of this range—which also forms the axis of the Ghat chain—the country consists of a succession of low hills partially wooded, with intervening narrow winding valleys, and as we approach the table-land of Mysore on the east, the hills gradually decline in elevation. The heavy forest tract, as usual, is confined to the western parts of Wynaad, and runs from the northern to the southern extremity of the district in a belt about ten miles wide and parallel with the crest of the Ghats. East of this we have the bamboo jungle, which, judging from the number of plants belonging to the Mysore flora that grow in it, and other features, is both hotter and drier than the corresponding region in Coorg. The mean elevation of the coffee zone in the heavy jungle tract is about 2,300 feet, and in the bamboo district about 2,000 feet. The prevailing rock in Wynaad is a gneiss, varying in appearance from a light coloured stone with a superabundance of quartz, to a dark syenitic-looking heavy and hard formation. There is a variety of schists, with their superficial strata generally in an advanced state of decay, and conglomerate (lateritic), kaolin, and soap-stone are not uncommon. The soil in so large a district, of course, varies very much. In the forest tract it is usually clayey, containing along with the clay, sand, and a little humus ; and varying in colour from a drab or pale red to a brown. In the bamboo district the soil is generally a brownish vegetable mould mixed with a little clay and sand, or chocolate-coloured loam. In some quarters the black cotton-like earth, already described, occurs, and seems badly adapted for coffee. The first estates in Wynaad were in the neighbourhood of Manantoddy, and at the present day every likely spot of ground for many miles round it is either under coffee, or shows traces of having been

so at no distant date. The station stands a little to the east of the margin of the forest tract, and is surrounded by low hills covered with a tall scrub or bamboo jungle. North of it, about five miles, there is an off-set of the Ghat-chain partly covered with heavy timber, which runs eastward into the bamboo tract, and on this a good many estates are clustered. The more westerly of these enjoy a rather favourable climate, but those on the eastern end of the spur are exposed to severe drought, and several estates there have had to be abandoned. The other estates in the forest tract in North Wynaad lie chiefly along the sides of the Tellicherry road. Beginning at Dindimul, seven miles west of Manantoddy, they stretch in nearly unbroken chain for about twelve miles to the west. The rain-fall in this quarter ranges from 100 to 120 or 130 inches in the year, but, as in Coorg, it descends chiefly in June, July, August, and September, and the soil being on some estates light and sandy, they suffered severely from recent dry seasons, more especially when the plants were old and exhausted. Beyond Peria there are a few estates too near the crest of the Ghats, which consequently suffer a good deal of damage from the monsoon. The coffee plants in the forest district of North Wynaad appear to give rather small crops until of considerable age, but arrived at maturity the returns are satisfactory, and some estates have, with little or no manuring, given good crops for ten or more years in succession. Weeds, particularly grasses, spring up abundantly on many of these estates. To the east of Manantoddy there are traces of a number of estates in grass or bamboo land, all of which have died out from poverty of soil, drought, or Borer, or all these combined in fatal alliance. This part of the district is also very low, the average elevation being about 2,100 feet, and the patches of jungle in existence are of a kind that gives no hope of coffee living, except in perfect shade. Within the last few years a good many estates have been opened to the north-east of Manantoddy, in the district traversed by the new road which is to connect Wynaad with Coorg. This tract lies in the bamboo district, and the soil is said to be very good; and in some cases shade is being industriously raised to protect the coffee from the protracted and severe dry season. The accompanying diagram, No. 1, gives the rain-fall at Manantoddy for 1867, by which it will be seen that it is considerably less than the average at Mercara. It must be remarked, however, that the rain-fall at the

latter station in the same year was unusually small, having been only 111 inches, and it is therefore highly probable, that the season in question was an exceptional one in both districts. It may, therefore, be safely inferred, that the ordinary amount of rain falling in one year at Manantoddy amounts to about 100 inches. Proceeding eastward, the nature of the flora speaks of a rapid diminution, and there is reason to believe that at the distance of twelve miles it will not be found to exceed sixty or seventy inches. In all other respects, including its effects on vegetation, the climate of North Wynaad may practically be regarded as identical with that of Coorg. In South Wynaad, the first estates were opened near Vythery, and now there is a large number in this district running out towards Culputty. In the immediate neighbourhood of Vythery the rain-fall is heavy, averaging about 130 inches. Of this, about six or seven inches are deposited during the north-east monsoon, and thus the severity of the dry season is somewhat mitigated. Towards Culputty the fall is much less, and the spring months are nearly as hot and dry as in the bamboo district. The soil in South Wynaad consists, for the most part, of a mixture of sand, clay, and vegetable mould in varying proportions, resting on decaying schists, red gravel, clay or a syenitic gneiss veined with quartz. Most of the estates in this district are situated in the heavy jungle tract, and some of them are of considerable age and very productive. A trunk road, leading down the Tambracherry Pass, is in course of construction, and when finished will be a splendid work and of immense advantage to the district, as it will bring it into direct and easy communication with the port of Calicut, situated about thirty-nine miles from the top of the Ghat. The rain-fall in this district, for the year 1867 will be found in diagram No. 1. In South-east Wynaad, a district of large extent, there is great diversity of soil and climate. About Cherambady and Dewalah, which lie in the heavy jungle tract, estates are rather favourably circumstanced as to soil and climate. To the north-east of these the picturesque Nelialum hill towers to a great elevation, touching with its southern extremity the forest tract, and then running out into the bamboo jungle. A few good estates are situated on or near this mountain mass, and those on the higher slopes are said to be very promising. Going eastwards from Dewalah, a chain of estates is seen running from near the Nelialum hills towards Goodaloor, and thence below the precipitous face of the Neilgherry range on to Seegoor. The whole of this group are in scrub or bamboo jungle, and the climate,

during the dry season, is intensely hot and scorching. The forest trees belong, for the most part, to the flora of the western portion of the Mysore plateau, and the climate is altogether badly suited for coffee, and notoriously unhealthy. In some places the coffee is kept alive during the dry season by irrigation, and where this expedient has not been resorted to, the losses from drought and borer have, in some cases, been very heavy. Behind Goodaloor, on the slopes of the Neilgherries, there is, however, a tract of quite a different character—the famous Ouchterlony valley. The mean elevation of this expanse is about 4,500 feet. On all sides it is surrounded with scenery grand beyond description, and, in its luxuriant mantle of coffee, it looks as if it had been made expressly for the growth of the plant. The exposure is north-west, and on the western side there is a lofty spur, culminating in the Neilgherry peak, that shelters it from the south-west monsoon, and on the east flank there is another spur giving protection in that direction. To the rear of the valley there is a forest-clad wall 1,000 feet high, and from the base of this the cultivated land runs out with an easy slope. The soil consists chiefly of the debris of the overhanging rocks, and fine vegetable mould washed out of the forests at a higher elevation, and is very fertile. The climate, too, is highly favourable, the air throughout the year being moist and cool, and in the dry season fogs descend nearly every evening, refreshing the plants after the heat of the day, and moistening the soil. Weeds are rather troublesome at all seasons, and some of the older coffee stems are covered with mosses and lichens, nature's hygrometers. In the north-east corner of the valley, at an elevation of about 5,000 feet, there are tea and coffee plantations in a very promising condition. As regards size, uniformity, and vigorous appearance, nothing could surpass the coffee in the Ouchterlony valley, and in no part of Southern India have estates been so largely and continuously productive. The chief crops in Wynaad are rice and raggee, but they are not produced in quantities sufficient to prevent the planter from having to send out of the district for supplies for his coolies.

Effects of destruction of Forest on Climate, &c. :—This subject has, with reference to Coorg, been fully discussed in a previous communication, but it may be useful to give a summary of the conclusions that have been arrived at respecting the whole of the coffee districts. In Nuggur and Munzerabad the clearings have not been numerous or extensive, the coffee, as already stated, being

chiefly cultivated under shade; but in Coorg and Wynaad, where this system has never been in favour, the clearings have been general and extensive. Many are of opinion that forest has the effect of increasing the amount of rain, but, although that may be true as regards European countries, it does not appear to be the case in India. In the former, rain is proverbially uncertain, mostly local, and influenced by local causes, such as the neighbourhood of a hill, but here it comes and goes with as much regularity as the seasons, being brought up by the monsoons which are dependent on causes fixed and far remote. These aërial currents, as they travel towards the Peninsula get thoroughly charged with moisture, and on reaching the land precipitation takes place from a sudden reduction in temperature. This, on the Western Ghats, is caused by the current striking against the colder hills and by reduction of density as it ascends, so that it can be of little consequence whether the mountains are bare or covered with dense forest. Adopting this theory, the forest in the coffee zone must be regarded as a result, and not the cause of the rain; and nature steps in to support this view, as every one must have observed how forest gets thinner and lower towards the east, just as the rain-fall diminishes in quantity. It follows, as a matter of course, that forest destruction in Wynaad and Coorg cannot have reduced the average amount of rain; but it is equally clear, that it has seriously altered the drainage, causing the water to run off rapidly instead of lodging in the woods to feed springs and streams, and render the air cooler and moisture during the hot season. The now periodical character of streams formerly perennial, the drying up of wells during the hot months, and the change in the flora near clearings, all testify to this in the clearest manner. As regards fever, the prevailing disease in the coffee districts, the change of climate resulting from clearings, does not as yet seem to have had much influence; but there can be little doubt that it will eventually mitigate the type, and render the disease generally less frequent.* In several districts, cholera has made its appearance when it was formerly unknown, but this may have arisen from increased intercourse with infected centres, although it is highly probable that the climatic changes may, on the introduction of the disease, have favoured its development. It is very evident, too, that forest destruction has, in various ways,

* Of course to ensure this the clearings must all be drained, and kept under cultivation.

affected animal and vegetable life. With respect to food supplies got from the animal kingdom game of all kinds has been rendered less abundant from want of cover, and fish from the drying and silting up and denudation of the banks of streams, in which they used to spawn and live. In the natural forest, too, there is a system of checks and counterchecks which maintains a balance between creatures regarded by man as useful or harmless, and those considered noxious or destructive. Thus the carnivora keep down mammals that prey on crops, while birds and various reptiles prevent the undue increase of insects. These last when kept within due bounds are highly useful as scavengers, and otherwise, and in the natural forest, they rarely become so numerous as to prove a pest. When clearings are made however, and nature's arrangements disturbed, the destructive species often increase to an alarming extent, owing to the disappearance of their enemies, the want of plants on which they used to feed, and the establishment of climatic and other conditions favourable to their multiplication. Of late years, owing to change of climate and other causes resulting from clearing, several additions have been made to the fauna of Coorg, various birds and lizards having come up from the Mysore plateau. At the same time some species of indigenous birds, which live in sparse jungle, have become more numerous, and as these are chiefly insectivorous, we see in this an effort on the part of nature to keep in check various kinds of insects, which have also greatly multiplied. As regards vegetation, the most obvious effects are an increase in indigenous species that grow in hot and dry situations, and the naturalisation of several that do not belong to the country. The most remarkable novelties are the *Lantana Indica*, introduced as a hedge plant, and the *Physalis Peruviana*, which must have escaped from some garden. The plant, however, that has been most influenced by denudation is the *Goat*, or *White-weed (Ageratum cordifolium)* to which allusion has already been made. This plant follows the planter into the most remote parts of the jungle, springing up as if by magic all over his clearings, and refusing to be exterminated.

To prevent further deterioration of climate, regulate the drainage, and maintain the fertility of the coffee zone, it appears desirable that the following regulations as to the conservancy of forest there should be adopted :—

I. That forest near the head waters of rivers or streams should be preserved.

II. That forest on the banks of streams—say to the extent of thirty yards on each side of a large, and fifteen yards on each side of a small stream—should be left intact.

III. That forests on or near the crests of the Ghats, and on the tops of all low hills should be kept standing. As regards the latter, it would be a safe rule to forbid felling above the lower third of their height.

IV. The slopes of all hills having a south-west exposure should be kept under forest, as neither coffee nor tea will thrive in such a situation.

V. Forest in the upper ends of ravines should be preserved, as it invariably gives rise to springs and streams.

VI. Forest surrounding paddy fields should be left, as they, as a rule, are irrigated by streams arising in it, which are sure to suffer from denudation.

VII. Forest on the slopes below an imperial road should be preserved, but if the trees are of a large size it should be cut down for some distance on the upper side, as the wind gets in through the clearing made for the roadway, and is apt to throw the trees down on the road.

IV.—REVIEW OF THE PRESENT STATE AND OF THE SYSTEMS OF COFFEE CULTURE IN SOUTHERN INDIA.

There are two distinct methods of coffee culture in Southern India, and as the one has often had some influence in increasing, and the other in diminishing the ravages of the borer, it becomes necessary to notice both in this report. The question, as to which is the better, has never been satisfactorily decided by planters, although a good deal of controversy has taken place on the subject. Any other issue was, perhaps, hardly to be expected, as each party has engaged in the dispute with a strong bias in favour of one system, and having a greater desire for victory than the elimination of truth. Party feeling too has run so high, that to praise one system in the presence of an advocate of the other, would often be considered sufficient grounds for a personal quarrel!

Of the two systems, that of shade is undoubtedly the older, and, therefore, falls to be considered first. The want of any satisfactory notice of it in works on coffee culture is strongly signifi-

cant of the light esteem in which it has been held, and yet it is the almost universal system followed on native property, and throughout two of our most prosperous coffee districts.*

Culture under shade :—This system is followed in other coffee producing countries besides India. In Java, it is usual to plant the *Erythrina Indica*, or the *Manilla plantain*, between the rows of coffee, and sometimes part of the original forest is left standing. Porter, in his "Tropical Agriculturist," says, "wherever coffee trees are planted in a plain, which is exposed to the sun, other trees must be planted near them to ward off its rays," and gives a quotation from "Brown's Natural History of Jamaica" to the effect, that "coffee thrives best in a cool and shaded situation." Dr. Wallich, when in charge of the Botanic Garden, Calcutta, had a considerable number of coffee trees there under the shade of a Teak plantation, and Dr. Royle remarks, that when he saw them in 1823, "nothing could be more healthy looking, or in better bearing." We also learn from a modern traveller in Brazil, that coffee thrives well in the shade of the great forests along the banks of the Amazon, and even yields two crops a year when care is taken in its cultivation.† It would also appear that in some of the West India islands the *Banana* is not unfrequently planted amongst coffee to afford shelter and shade. In India, shade has been long used in native coffee gardens, and this is all the more remarkable, seeing that it is not thought necessary in Arabia, from which they got the first supply of seed, and derived their ideas as to the mode in which the plant should be cultivated. When visiting the old garden on the Bababoodens, in which coffee was first cultivated in Southern India, I made some inquiries on this point, and was told that for some time after its introduction the plants were grown in open ground, but it having been found in course of time that they did not succeed in that manner, planting in forest shade had been adopted. It would thus appear that the native planter was led to cultivate his coffee in shade by experience, the best of all teachers, and that he had very good reasons for a change of system. It is also a remarkable fact that the first European planters in this country followed the example of the Native, and their plantations, after the lapse of from twenty to forty years, are still flourishing and productive! In a state of nature the coffee grows in moist forest where it is screened from the scorching solar rays by the foliage of other trees; and hence when placed in dry hot

* Nuggur and Munzerabad.

† Agassiz "Journey in Brazil."

situations without any protection, it languishes or dies out. As an element of climate the humidity of the air throughout the year is of much more importance than the rain-fall, and unfortunately in most parts of the coffee zone, the winter and spring seasons are, notwithstanding the heavy rain-fall during the south-west monsoon, particularly dry and often very hot. It is in this particular that the climate of our coffee districts chiefly differs from that of Ceylon, where the plant has been so successfully grown in open ground, and it is this that renders shade absolutely necessary in India, while it would be perhaps useless or hurtful in the other country. The insular nature of Ceylon gives it a climate perennially moist, and frequent showers and dews cool the air and refresh the plants during the hottest months of the year; but in India, often for months in succession, there is not a drop of rain, while at the same time the sun is as bright, and the air as dry and nearly as hot as on the plains of the Carnatic. There are two distinct methods of shade culture, the coffee in the one being planted under the original forest, while in the other, the ground having been cleared, trees are planted or allowed to grow between the rows of coffee to afford shade. The former may be termed *natural*, and the other *artificial shade*. In selecting a site for the culture of coffee under *natural shade* forest, consisting of trees that lose their leaves during the hot season, or which are too tall, should be avoided, and a tract chosen in which the trees are of moderate height, and either evergreen, or retaining their leaves during the spring months. Such forest is generally met with on low rounded hills, or on the slopes of ravines in the coffee zone. The under growth usually consists of shrubs, seedlings of the trees, some hardy ferns, and arums and other shade and moisture loving plants, and must be cut down and piled in rows. In this way the plants decay gradually fertilising the ground, whereas if burnt there is a great chance of many of the forest trees being fatally injured, and the superficial mould is so much dried that it runs the risk of being washed away by the rain. In the season following the cutting and piling of the undergrowth, the ground is cleared of weeds, and the coffee planted out in the usual manner. In the case of *artificial shade*, a locality suitable for coffee having been selected, the forest is cut down and got rid of by piling or burning. Of the two modes, the former, although more expensive, is much the better, as the intense heat of the *burn*, dries and scorches the ground in a very prejudicial manner, while all the valuable soluble constituents

of the ashes, and a portion of the earth is conveyed to the nearest nullah by the first shower. The ground having been cleared, the coffee is put down in the usual manner, but the rows had better be a little farther apart than usual to provide space for the shade trees. After planting, a plentiful supply of the *charcoal tree* (Sponia Wightii) generally springs up, with here and there an *Atti-marah* (Ficus glomerata) or *Sand-paper* tree (Ficus asperrima). All these, more especially the first, are well adapted for shade. If, however, nature does not aid the planter by trees of spontaneous growth, he must take means to supply the deficiency, and as shade is much required by the coffee when young, any check at that period being highly prejudicial or even fatal, the trees selected for planting must be of such rapid growth, as that in one year or eighteen months they will protect the coffee with their side branches. As temporary means, until more lasting trees can be grown, the castor-oil, plantain, and potato tree (Solanum arboreum) may be used with advantage. The best of all trees for permanent shade is the jack, but it is of slow growth, giving but little shade until from six to eight years old. The atti-marah, already mentioned, is an excellent shade tree, and has the peculiarity of losing its leaves in the monsoon, when shade is not required. The Busserah-marah (Ficus ——?) is also one of the best of shade trees, and both it and the atti-marah are easily raised from cuttings. The charcoal tree seeds very freely, and the seed should be sown in beds and the plants removed when very young, as they do not bear transplanting well.* It lives for about forty years, but, as it is rather liable to accidents from winds and to the attacks of large borer† which kill or render it weak, it is better to regard it as merely temporary shade and to have jacks coming up to take its place. The effects of shade on the coffee plant are various, and are due to the diminished light, reduction in temperature, increase in moisture and shelter. Light being the great stimulant of the functions of vegetable life, its partial exclusion causes them to be performed with diminished activity, so that coffee in the shade as compared

* List of other shade trees:—Poinciana regia; Macaranga, several species; Cassia florida; Acacia, several species; Erythrina Indica; Mangifera Indica; Thespesia populnea; Bauhinia racemosa; Bauhinia tomentosa; Citrus aurantium; Citrus bergamia; and other species; *Guava*, Psidium two species; Guazuma tomentosa; *Jamoon* and several of the large myrtaceæ.

† The grub of one of the Hepialidæ.

with that in open ground grows more slowly, is later of coming into bearing, produces somewhat smaller crops, and ripens the berries more slowly. As regards the temperature in shade, the Messrs. Becquerel found that during summer in France, temperature in free air slightly exceeded that under trees, while in winter the contrary was the case.* On these hill ranges the temperature, both of the air and soil in forest, is less during the dry season than in open ground, but during the monsoon it is probably somewhat warmer in the former than in the latter. On looking at a coffee tree under natural shade, the most careless observer cannot fail to be struck with the difference in appearance that exists between it and one fully exposed to the sun. The beautiful deep green colour of the leaves and their great size are very striking, while the tall bare stem, and the umbrella-like expansion of branches at its top are not less remarkable. A closer inspection will discover that the stems have become bare from the death of the lower branches, but that their loss is pretty well compensated for by the great development of wood in the top, into which all the sap and the vigour of the tree are thrown. The young or fruit-bearing wood will also be found curiously long-jointed, and not so robust or disposed in the same regular manner as in unshaded trees. These peculiarities are not so strongly marked in plants grown in artificial shade, which in general appearance, and time of coming into bearing, differ but little from plants in free air. The coffee in natural shade rarely produces much crop until five years old, and whether the shade be natural or artificial, trees grown under it are undoubtedly less productive than those in the open. It will thus be seen that there are some disadvantages attending shade culture, but these are quite compensated for by the greater longevity of the plants, the certainty of a fair crop, the decreased liability to suffer from droughts and high winds, the much lower rate of working expenses, and great immunity from borer. The retention, too, of the natural forest as shade obviates these disastrous effects on climate and drainage that follow denudation, and prevents the washing away of the surface soil during the rains. The degree of shade necessary in a given locality is a question of great nicety, and hardly any general rules can be given on the subject, as climate, exposure, elevation, and the nature of the forest must all be taken into consideration. Generally

* "Quarterly Journal of Science," April 1867, p. 280.

speaking, in forest near the eastern margin of the coffee zone all the trees should be left standing, and if large openings exist, they should be filled up by planting trees of rapid growth. In forest farther west, a judicious thinning may be necessary, but this should be done with great caution, as forest trees, when the ground under them is cultivated, seem more liable to perish, and when deprived of their neighbours, are liable to be thrown down by the wind; accidents which, in course of time, might render the shade insufficient. At high elevations, say from 3,000 to 4,000 feet, less shade is required than at lower sites, owing to the diminished air and earth temperature. As to the kind of shade suitable for a given locality, it appears that natural shade is the better for places of low elevation or lying far to the east, whereas artificial shade is preferable on estates farther to the west, and in situations where the trees are deciduous or too tall. Before leaving the subject, it may be as well to remark, that insufficient shade does not, in the slightest degree, lessen the liability to borer, but appears to have the opposite effect.

Culture in open ground:—The general preference hitherto given to this system in Southern India seems to have arisen from most of the earlier planters having been trained in Ceylon, where it is the universal practice, and from its being recommended in nearly all hand-books; these having mostly been written by those who had learned the art in the same school. It was very natural for men coming from the famous coffee producing island, and seeing tracts of country resembling in so many respects the districts they had left, to suppose that the system which had proved so successful in the one would do so in the other. On the other hand it is strange, that the too often partial success, and very frequent failure that attended all these earlier experiments, did not lead the planters to see that some modification of the plan of culture was necessary in India. Nothing could afford stronger proof of how much men in general are wedded to systems, and how few there are who possess those mental qualities that enable them to observe and reason on what they see, and liberate themselves from the trammels of tradition. In the present instance, the staunch adherence to "custom" may be partly accounted for by the fact, that the great majority of those engaged in coffee culture have had no special training to qualify them for the pursuit, and although natural abilities may go a long way, still the principles of horticulture and agricultural chemistry do not spring up spontaneously in the human mind. No English

farmer at the present day would venture to send forth his son on the same pursuit, without a full acquaintance with the scientific principles of the art, and the planters themselves will, I am sure, agree with me, that such preliminary knowledge, as well as practical training, is most essential for those undertaking the culture of coffee. It would be useless to give here a detailed description of culture in open ground, but I must again remark, that the use of fire, to get rid of the vegetable covering of the ground, is most prejudicial. By combustion all the volatile constituents of the plants are transferred to the atmosphere, and the inorganic left in a state and position in which they are sure to be carried away by rain. The powerful flames too of the *burn* consume a great portion of the superficial layer of humus, and dry the remainder and subjacent soil so much, that they also are liable to be washed away. On the contrary, when the trees are piled and left to disappear by the slow process of decay, their constituents descend to the soil to fertilise it, and the wash is not nearly so extensive.

General Remarks:—I believe there is no portion of the coffee zone in Southern India in which the plant may not be grown under shade, but at the same time, at high elevations with a moist climate, it will not be found necessary, and the productive powers of the tree would be greatly diminished by its presence. It is by no means easy to say where shade will be required and where it will prove injurious, but it may be taken as a safe general rule, that wherever there is considerable elevation—say over three thousand feet—and great perennial humidity,* the plant will thrive best when freely exposed; but, on the other hand, wherever there is a long and dry hot season, and the elevation is under three thousand feet, the protection of shade will be found advantageous. Irrigation has been tried in such situations, but it does not meet all the requirements of the plant, when exposed for a long period to intense heat and great dryness of the atmosphere. It would no doubt, however, prove advantageous on some estates in the dense jungle tract, where the wet and dry seasons are characterised by extremes, for although the latter may be by no means very hot, still the sudden change from a state of constant saturation to one of comparative dryness, is very trying to the plant. In most cases too, the introduction of

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* If the climate is dry, shade may be necessary up to 3,500 or 4,000 feet.

irrigation on such estates would be comparatively easy, as there is generally an ample supply of water, and sufficient fall.

Usual mode of planting:—When about to be removed to their permanent place, the plants are rudely removed from the seed-beds, and their roots having been pruned at discretion by a cooly, they are carried away to be planted. This process very nearly reduces the plant to the condition of a cutting, all the delicate fibrils by which it gathers its food from the soil being removed or injured. Arrived at its destination, an opening is made for it in the ground, in the shape of a small pit, or a hole made by a crowbar flattened at the end. Plants thus treated receive a great check, and seldom acquire that development of root, which follows more careful transplanting and is so essential for vigorous growth. *Ball-planting* is, of course, the best plan, but planters object to it on account of its expensive nature. This, it appears to me, would be more than compensated for by the small per-centage of plants that would perish, and by the vigorous and rapid growth that would ensue. The number of plants lost in new plantings under the present system is very great, and the cause of much expense.

Weeds and Weeding:—Weeds are great enemies to the coffee as they are to every cultivated plant. A weedy estate is always an unprofitable, and very often a borer-frequented estate. The chief weeds are *grasses*, small *Cyperaceæ* most fatal to coffee, *Spider-worts*, and the *Goat-weed* already alluded to more than once. This last is stigmatised by Liebig as a "most pernicious weed for woody plants," as it withdraws the potash from the soil, and he recommends that it should be gathered, burned, and the ashes returned to the soil. There is a system called *hand-weeding*, which consists in carefully removing from the first all the weeds by hand, instead of by *mamoty*. In this way the soil is never disturbed, and its surface gets gradually covered with moss, so that it is impossible for it to suffer from wash. At the same time there are some disadvantages, for, as the soil is never dug, it gets hard and offers considerable resistance to the roots, and its dense upper crust prevents the oxygen of the air from entering the earth and coming in contact with the rootlets. Some of the grasses and cyperaceæ which the planter finds it so difficult to get rid of, might be destroyed by cropping the ground with the Sweet Potato, which completely clears the ground of all the enemies of the coffee. Weeding is, from want of labour and to save expense, very often much neglected, the estate

being gone over but two or three times in the course of the year, instead of once every six weeks or two months. On very steep land it is better not to remove the weeds during the monsoon, as they prevent the soil from being washed away. Weeds should be buried or burnt. Piling them round the stem of the coffee is a most pernicious system.

Digging :—This operation is very seldom resorted to, partly on account of its expense, and partly because its importance is not sufficiently recognised. The tendency of the heavy rain is to wash all fertilising materials deep into the soil, and as these are never brought up, the roots of the plant are to a great extent starved. In many soils, especially those of a clayey nature, a good digging is as beneficial as the application of manure ; as by it fresh food is brought in contact with the feeders—the fibrils—of the root, and the lower portions of the soil exposed to the very beneficial action of the air and moisture. The common *mamoty* is a dangerous digging implement in a cooly's hand, as he goes recklessly to work, but too often cutting up the roots, and even hacking the stems of the plants. The forked mamoty should, therefore, be always employed in turning up the soil on a coffee estate. Loosening of the soil is rather dangerous on very steep ground, but might be performed at a period of the year that would allow of its settling down, before the setting in of the rains.

Draining :—Is of great importance on coffee estates, as not only does it withdraw the water stagnant and therefore injurious in the soil, but also prevents the washing away of the soil by rain. I have already noticed the extremes of moisture and drought to which the coffee tree in Southern India is subjected, and have no doubt the ill effects of the former would, to a great extent, be obviated by more extensive drainage. In undrained land the water lodges, generates noxious gases, and so injures the roots of the plants. When drained, it filters through the soil, conveying fertilising materials, renewing the supply of air in the interstices, making the earth looser, and gradually converting organic and inorganic matters into food for the plant. It also enables the planter to dig in situations where the disturbance of the soil would otherwise be unsafe, and makes a given quantity of manure produce much better effects than in undrained soil. The drains used on a coffee estate are all what is called surface drains, being open, about fifteen inches by fifteen inches, and having a gradient of from one in fifteen to one in twelve. They should be about

fifteen or twenty yards apart in steep places, and must be watched and regularly cleared during the rains. In badly drained land the leaves of the coffee turn yellow, and the plants often rot at the roots and die. Sometimes during the rains they are affected with a disease called *Rot*, in which the tissues of the leaves undergo rapid decomposition, and the leaves turn black and fall off. There is no doubt, too, that the want of vigour displayed by the coffee on so many estates, and which predisposed them to attacks of the borer, has been partly produced by want of proper drainage; and a good authority says, "that surface draining is the most profitable operation in coffee culture." Foresters at home well know its value, and thousands of acres of thriving timber plantations may be seen on bleak moors and mountain sides, which, but for the draining, would never have grown any thing more valuable than heath or coarse grass.

Pruning:—When left to nature, the coffee tree in India becomes an unsightly bush, with several stems which run up to the height of ten or twelve feet. The planter does not allow his trees to produce more than one stem, and he keeps this at a moderate height, and encourages the lateral expansion of the plant by topping. In exposed situations the stem should not be allowed to exceed two or two and a half feet in height, as when higher, especially if the soil be poor, it either withers at the top, or gets broken and killed by the monsoon. In sheltered spots, stems may safely be allowed to attain the height of three or four feet. The object of *topping* is to keep the plant at a convenient height, to preserve it from injury from wind, and to cause it to throw out vigorous branches. The operation of pruning is resorted to with the view of increasing the amount of fruit, but as a rule, it is very badly done, and often all but neglected. In order that a tree may produce fruit, it must elaborate from the sap and have ready a certain amount of surplus nutritious matter, and this it is enabled to effect by the agency of the leaves. If, however, there is too much wood left on the plant, it draws on the reserve store, consuming what would otherwise have been expended in fruit bearing; and, on the other hand, should too much be removed, there is not sufficient leaf left to elaborate the secretions, and so the plant is checked and stunted, and the amount of crop diminished. It will thus be seen that pruning requires no little care and judgment, and the great aim of the planter should be to prune, so that there will be enough of bearing wood left to produce all the fruit that he thinks his tree capable of carrying, and enough of leaf to keep the tree in

vigorous health and ripen the crop. It should also be his object, when the plants are young, to repress any tendency to overbearing, which weakens or fatally exhausts them, and when arrived at the stage of full bearing, to endeavour to get them to produce, as nearly as possible, the same amount of crop from year to year. As topping causes the coffee to assume a bushy habit, all the secondary branches growing within six inches of the stem should be removed, and the others so thinned, as that light and air may have free access to every part of the plant. The operation of pruning should be performed immediately after crop, as the plant is thus relieved, before the trying hot season, of the drain of superfluous wood. Should pruning be delayed till the flowering season, the plant is needlessly taxed and weakened. A great deal of misconception exists on these points, and estates are, perhaps, oftener injured by neglect of or bad pruning, than any other cause.

Manuring:—Until quite lately, manuring has been generally neglected on coffee estates, owners seeming to think that the natural resources of the soil were ample and inexhaustible. No greater mistake could be imagined, and the farmer or market gardener who would act on the same principle in England, would simply be regarded as a lunatic. The coffee plant indeed, for its size, requires an unusually large amount of nutriment, and as its roots cannot go very far in search of this, the upper portion of the soil in which it grows soon gets exhausted, unless supplied with manure. In its application, the great aim should be to place it where it will be most accessible to the fibrils of the roots, by which it is taken up, and it should also be remembered that the more thoroughly it is pulverised and mixed with the soil, the better will it act. On laying bare the roots of a coffee tree it will be seen, that for some distance around the base of the stem there are few or none of the minute feeders, the fibrils, and hence manure deposited or dug in there must be of comparatively little use. The proper place is immediately under the extreme ends of the branches, or a little beyond that, and the manure should be dug in at the season when vegetable growth is about to become most active, as absorption is then most vigorous. The proper period for manuring coffee in Southern India, is therefore, immediately after the pruning season, or about the time of flowering, and the operation is then likely to increase the number of flower buds.* It would be

* This is more particularly the case with manures of such speedy action as Guano and superphosphates.

impossible here to enter into the merits of the various manures that have been proposed or tried for coffee, or even to enumerate them all. The great principle to be kept in view is, that they will keep the soil in a state of fertility by adding the substances withdrawn from it and not merely stir up or bring into use its original productive resources. Farm-yard and other natural manures, consisting of the excreta of animals and decayed vegetable matter, are the most fertilising to the soil, but when applied freely, have a strong tendency to cause grasses to spring up. Bones form excellent manure for coffee land, and the finer the state of division to which they are reduced, the quicker and more efficiently will they act. In the state of superphosphate of lime (that is bones dissolved in vitriol) they are even more effectual, as that salt is for the most part soluble in water, and therefore readily absorbed. Lime is also an excellent application, but the planter in using it must remember, that he is drawing, so to speak, on the capital in his soil, and should therefore restore the products removed by the plant, by the application of a natural manure. Lime acts chiefly by expediting the decay of organic substances, and setting free the alkalies. Guano is a manure more adapted for annual plants—such as root crops—than perennials. Its efficacy arises from the ammoniacal salts that it contains; and there seems little doubt that all highly azotised manures like it, stimulate vegetation chiefly by stirring up the natural resources of the soil. They, in short, stimulate but do not feed the land. To speak of the various patent manures now on sale would be impossible. To enable the planter to judge of their applicability for his purpose, he must find out the general composition and wants of his soil, and the ingredients contained in the manures, and to do this properly, he will require the aid of the agricultural chemist.

TABLE OF MANURES.

Name of Manure.	Quantity to be applied.	Mode of application, &c.
Farm-yard Manure...	1 cooly load to each tree	In stiff clay soils apply fresh dung, as it helps to loosen and open them: in saudy or porous soils apply well rotted dung.
Bones...	6 cwt. per acre ...	The smaller they are broken, the quicker and more effectually do they act.

TABLE OF MANURES.—*(Concluded.)*

Name of Manure.	Quantity to be applied.	Mode of application, &c.
Superphosphate of lime	2 to 3 cwts. per acre.	Should be mixed with ashes, and will be more effectual if combined with farm-yard manure.
Guano	3 cwts. per acre ...	Must be reduced to fine powder, and to ensure equal distribution, be mixed with two or three times its weight of dry earth.
Poonac (oil cake) ...	8 cwts. per acre ..	Should be reduced to fine powder, and well mixed with the soil.
Lime...	8 to 10 cwts. per acre.	Should be applied immediately after slaking, and not put too deep, as it gradually sinks into the soil. Not to be applied at same time as other manures.
Wood ashes	10 or 12 bushels per acre...	Must not be buried too deep.

N.B.—The usual method of applying manure by placing it in a pit near the foot of the tree is a very rude and wasteful plan.

Reviewing the whole system and state of coffee culture in Southern India there seems great room for improvement, the soil and trees being in a great measure left in a state of nature. Digging, the most essential of all horticultural operations, is very rarely practised, and draining is not sufficiently attended to, while the only manure that the ground receives, is that supplied by nature in the shape of withered vegetation, and rain! Weeds, those arch-enemies of cultivated plants, are allowed to run riot, and pruning is rarely performed oftener than once in one or two years. As already stated, too, not a few mistakes have been made in the selection of land. In some cases the sites chosen have been in exposed places too near the crest of the Ghats, so that year after year the plants have perished from the severity of the monsoon. In other instances they were too far to the east, and the trees died from the combined effects of drought, exhaustion, and borer. One other very common mistake has been the opening and planting of more land than the owner had means to cultivate properly, and this appears to have been occasioned chiefly by the exaggerated ideas, at one time entertained, as to the profits of coffee culture; men seeming to think that coffee crops were not liable to variation or accident, and that their gain would be in exact proportion to the extent of their estates. Such ideas, it need hardly be said, have received a rude

shock, and a dear-bought experience has led many to see, that one acre highly cultivated will be more profitable than ten managed according to the ordinary system. In every part of the world, where education has triumphed over barbarism, the advantages of high culture for all kinds of crops have been practically recognised, so much so, that the state of agriculture in any country may be taken as a gauge of its degree of civilization. That planters generally should have so persistently adhered to a bad system, seems to have arisen from the fact that nearly all of them were unacquainted with the ordinary principles that guide the cultivator of the soil. A change of system is now urgently wanted, and owners must make up their minds to a great increase in working expenses, in order to realise the large profits which this branch of industry is doubtless capable of yielding. When such an augmentation may be impracticable, then the better course will be to abandon all the poorer parts of estates, and concentrate the labour and resources at command on the remainder. Indeed, I would recommend this measure to be adopted on all estates, no matter what the resources of the proprietors, as from various causes a vast amount of utterly worthless land has been reclaimed, and never has or can be made to pay the mere cost of keeping it clean. Of course, high culture is equally necessary, whether the estate be without any protection or in shade, and the above remarks are equally applicable to either mode of cultivation. An unhealthy stimulus was also given to coffee culture by the meretricious value for some time put on such property, as this enabled planters to get aid from capitalists with an ease, and to an extent far beyond safe limits. For a time all went on apparently flourishing, and all concerned congratulated themselves on their bright prospects, but a few bad seasons, the ravages of the borer, and a crisis in the money market, induced a severe reaction. Coffee shares, at the present moment, are all but unsaleable, while estates have become sadly depreciated in value, and are looked on as very questionable securities. The effect of all this has been to place the planter in a most trying position, and in some cases his difficulties have been such as to force him to neglect, or even abandon really good property. The alarm about the borer, too, was at one time so great, that even men of ample means paused and curtailed their expenses, a step which in some instances, I have no doubt, brought upon them the very evil they dreaded, as a neglected estate is almost certain to become infested with this terrible pest. It is to

be hoped, however, that the severe ordeal through which coffee culture is now passing, will lead to its being established on a firmer basis, conducted within much safer limits, and carried on in an improved manner. No fact should be more strongly impressed on the mind of the planter, than that cheap and careless culture will always be profitless culture. The coffee plant is an exotic, and to be productive, it must be placed in the most favourable circumstances, and carefully tended. There is no domesticated plant in existence that does not require such attention, as it is leading an artificial life, and it has become an established maxim both on farm and garden, that the higher the cultivation, the greater will be the amount of crop and profit.

V.—NATURAL HISTORY OF THE "BORER," AND REVIEW OF THE CAUSES THAT HAVE RENDERED IT SO NUMEROUS AND DESTRUCTIVE.

XYLOTRECHUS QUADRUPES *(Chevr.)* ORDER, Caleoptera; FAM. Cerambycidæ. *Synonyms*—Clytus coffeophagus, (Dunning); Clytus macaensis; Clytus—? (Neitner); Clytus—? (Bidie); Coffee Fly; Borer Beetle: and of the *Larva*, the Borer; White Borer; and the Worm.

DESCRIPTION OF THE BEETLE.—See Figs. 3 and 4, Pl. iii.

This is a very pretty insect, being slender and elegant in form, and beautifully colored. The female is distinguished from the male by her superior size, and by the ovipositor being often partially protruded. She is generally from six to seven-tenths of an inch in length, and measures from eight to nine-tenths across the wings. The male is considerably smaller.

Head depressed and flattened in front, posterior portion lustrous black, anterior portion pale greyish-green from numerous hairs of that colour.

Labrum slightly exserted and rounded.

Mandibles horny, robust, sharp-pointed and incurved.

Maxillary palpi somewhat slender and clavate, the last joint long and thick. See Fig. 3, Pl. iv.

Labial palpi clavate, with the last joint thick and slightly truncated.

Eyes lunate, curved round the angles of the head, large and brilliant.

Antennæ of moderate length, eleven jointed, filiform, first joint longest, thickest and curved; third, fourth, fifth, and sixth joints slightly dentate. See Fig. 1, Pl. iv.

Prothorax round or slightly oval, globular, covered with greyish-green minute hairs, and marked above with a black spot, and on each side with a black dot.

Elytra sometimes scarcely covering the abdomen, broad at their base and very slightly tapering, convex, rounded at their extremities, black, marked with white or yellow transverse diagonal and curved lines, the last of which form three figures like the inverted letter V.

Legs the front pair shortest, the second pair longer, and the last pair about as long as the body: four posterior femora of a pink colour, third joint of the tarsi bifid, and the last armed with a sharp double hook. See Fig. 2, Pl. iv.

Pupa:—The insect in this stage of its existence is generally found in a roomy cell prepared by the larva, immediately under, or only separated by a thin layer of wood, from the bark of the tree. It is shorter and thicker than the larva, and exhibits the antennæ, limbs, elytra, &c., disposed in the manner usual in the family. See Fig. 2, Pl. iii.

Larva is at first not more than the tenth of an inch in length, and very slender. When full-grown it is from three-fourths to one inch in length, broadest at the head, and gradually tapering towards the other extremity, of a pale yellow or whitish colour, and fleshy consistence. The body consists generally of eleven segments, and is apodous, but three or four of the abdominal rings are each provided dorsally with a tubercle, which aids the insect in moving forwards, and in fixing its body while lengthening its tunnel. The head is hard and scaly, flattened above, and armed with very powerful mandibles (See Fig. 4, Pl. iv.; Fig. 5, gives a side view of a mandible,) with which it reduces the wood to a fine powder. This forms the food of the voracious creature, and having passed through its body, is compacted behind it in the tunnel, and so agglutinated by some mucilagenous fluid, that it may be removed like a cast of plaster of paris.—See Figs. 1 & 6, Pl. iii.

Ova:—The eggs (Fig. 5, Pl. iii.) are placed deep in the little cracks,* which always abound in the bark, and fixed by some secretion that is voided at the time of deposition. The ovipositor is a telescopic split tube, and when not in use, is drawn up into its sheath,

* See Fig. 6, Pl. iv.

which terminates the abdomen. It is capable of being protruded to a considerable length, which enables the female to place the eggs out of the reach of danger, and is armed at its extremity with two little round bodies bearing a few hairs, which are probably used to clear out and enlarge the crevice where the eggs are placed. It is difficult to ascertain the number which one female will lay, but the average is probably from 150 to 200. The eggs are placed in little clusters containing from five to eight each. They are very small, about the size of a pin point, and of a white color. Under a low magnifying power, they are found to consist of a pearly-white thin membrane, and are of a pyriform shape. They gradually enlarge in length as the embryo progresses, until at length the little larva can be seen through the membrane. They are mostly deposited in sunny places, and hot sunshine favours, while cold damp weather retards or prevents their hatching. Heavy showers destroy them, and they are eaten by several minute insects. They are not often deposited, and do not hatch readily in shade.

General History of the Insect :—When the beetle emerges from its pupa covering, it finds itself in a dark chamber. At this time it has not attained its full size; the hard case of the body is not so strong as it afterwards becomes, and the colours of the elytra and other parts of the body are dull or imperfect. Accordingly, it remains in the place of its birth from three to ten days, until every part of its frame has attained its due development, when, moved by irresistible instinct, it sets to work, and with its powerful jaws cuts a tunnel through the barrier that separates its cell from the surface of the tree—(See Fig. 6 *a*, Pl. iv). One might suppose that in performing this operation, the little creature would be just as likely to go in the wrong as the right direction, but this is prevented by the larva when about to be transformed into the pupa state, always going to rest with its head towards the exterior of the tree. Very often, as will be seen in Fig. 6, Pl. iii., the larva carries on its work of destruction in the root of the tree, and were it to undergo its transformations below ground, the beetle would never be able to escape. With marvellous instinct, however, the borer always returns to the stem to prepare the cell for the pupa and beetle, except in some rare instances in which the surface of a root has become exposed to the air by the washing away of the soil. The beetles may be met with at all seasons, but are most plentiful just after the monsoon, and throughout the dry season. They

live from twelve to twenty days, apparently feeding on vegetable matter, but are not often seen at large, although sometimes met with on the leaves or bark of the coffee tree. They delight in bright sunshine, and are very active in their movements and not easily caught. At the season when most abundant, they sometimes appear in considerable numbers in the windows of the planter's bungalow; and walking through a field of coffee it is no unusual thing to find two or three adhering to one's clothes. Trees attacked by the borer always occur in patches, the mischief beginning in one and gradually extending to the others. The females in general select warm sunny places for depositing their eggs, avoiding exposed and shady situations. Indeed, shade seems to be obnoxious to them, and when the ova chance to be deposited in trees protected by it, they do not hatch. The female beetle is much more numerous than the male, and is active during her whole life in depositing ova. When engaged in this operation, she moves about briskly on the bark of the coffee tree, looking for a convenient crack or chink in the bark, and having found this, the ovipositor is rapidly inserted, and a few eggs deposited and fastened in their place, where they are so securely hidden, that they can only be seen by carefully removing some of the outer portion of the bark. In from eight to fifteen days they are hatched, and the young grub, a very minute creature, begins to exercise its mandibles, and derives sustenance from the inner juicy layers of the bark. Its presence there causes the outer portion to rise in a well defined ridge (See *a*, Fig. 6, Pl. iv.) as if a wire had been passed between it and the wood. This is an unfailing symptom of the enemy having taken possession of the plant, and enables the planter to detect an infested tree long before any other signs of the scourge have become manifest. As the larva increases in size and strength, it dips into the tender young wood, and at length drives its tunnel in all directions, having apparently rather a predilection for the hardest and most sapless portions of the stem. As will be seen from Fig. 6 of Pl. iii, the tunnel pursues a very winding course, but rarely touches that of another individual, and never emerges on the surface of the stem. The empty part of the tunnel in which the borer lives is rather longer than itself, but it pushes forward and fixes its body by the dorsal abdominal tubercles, and the rings generally. The tunnel is lengthened by the action of the powerful gouge-like mandibles (See Fig. 5, Pl. iv.) and the wood powder having passed through the intestine of the grub is, as already mentioned, excreted and firmly compacted behind it. The

work of destruction is carried on by the larva for about or a little more than nine months, when, working its way towards the surface of the stem, it prepares a chamber immediately under, or but a short distance from the bark, in which it goes to rest, and becomes transformed into the pupa. In this state it continues for from thirty to fifty days, the time depending a good deal on the state of the weather. The entire existence of the insect, from the deposition of the ovum till the death of the beetle, does not exceed twelve months, and in this it differs from other members of the Cerambycidæ, who are said to pass from two to three years in the larva state; although, it must be confessed, that we have but little accurate information concerning the obscurer points of their life-history. As regards the coffee borer, there can be no doubt that the life of an individual in all its stages is comprised within twelve months, as instances have repeatedly come to my notice of the beetle existing in stems less than eighteen months old. The season at which the beetles appear differs slightly in different districts, but there is generally a numerous brood on the wing after the monsoon, and again about the middle or end of the dry season. The eggs are also, of course, deposited at these seasons, and the pupæ are to be met with in greatest abundance in the month of September, or about the beginning of October. A small per-centage of the pupæ are abortive, or decay from water getting admission by old holes through which beetles have escaped, and it sometimes happens that the chamber in which the beetle appears, is so far from the surface of the stem, that it is never able to effect its escape.

Symptoms of the presence of Borer in a tree:—The first sign of the borer being in a tree is the ridge on the bark, already alluded to, which is generally found near the base of the stem,—See *a* Fig. 6, Pl. iv. When the work of destruction has gone on for some time, the older leaves turn yellow, while the younger ones have often a curly or waved appearance, and are of an unhealthy pale green colour. As the energies of the tree get exhausted, old leaves drop off, and sometimes a great many young shoots appear on the stem and primaries, as if the plant were trying thus to maintain its existence. If the tree is bearing crop at this time, much of it falls off, while the remainder passes from a sickly-green into a yellow colour, and finally gets black. At length, when the circulation of the sap is arrested by the nearly total destruction of the roots and stem, the whole plant withers, and if a shake or wrench be now given, it

will snap across. Trees much injured by borer are often covered with lichens, and many planters think that even when looking pretty green, they have not so firm a hold of the ground as sound trees. Such trees also occasionally put forth an unusal amount of blossom, an incident by no means uncommon in plants in a sickly state, but a great many of the flowers prove abortive, and the fruit which is produced is of inferior quality, or does not arrive at maturity.

Injuries inflicted on the Stem and Roots by the Larva:—During the earlier years of the ravages of the borer, the general immunity of young coffee trees led many to think, that only old trees were liable to its attacks. More extended experience, however, has shown that a coffee tree is just as likely to be assailed the day it is planted, as at any future period, but with this important difference in the results, that while an old tree may recover, a young one rarely or never does. In a young plant the ova are deposited six or eight inches from the bottom of the stem, and when hatched, the larvæ go down to the thickest portion and to the tap-root, which they shortly reduce to powder, only leaving the bark intact. In a stem not thicker than the little finger at the base, I have found as many as two beetles, one pupa, and four larvæ. In large stems the borer often tunnels only within a foot or eighteen inches of the bottom of the tree, but usually the depredations extend throughout the entire stem. In most cases when the grubs are numerous, they attack the roots as well as the stem, but by a marvellous instinct, as already stated, never by any chance remain there to undergo the changes into pupa and imago. On looking at the exterior of a stem that has for some time been infested with the borer, numerous small holes through which the beetles escaped will be seen (See Fig. 6, Pl. iv,) and the bark, according to the extent of the depredations, will either be dry and cracked, or completely withered, while some of the primaries may have disappeared, leaving a cicatrix, the furrows on which intimate that they were actually amputated by this destructive creature. If the root remains safe, some of the lower branches may continue green and bear fruit, while the upper parts of the stem is dead and generally devoid of branches. In young trees that have perished from borer, the cause of death is not always very apparent until they are broken, but in old ones the tell-tale holes through which the beetles have worked their way to freedom, light and air, at once indicate the cause of the disaster. The damage done to the roots is usually very exten-

sive, as the larvæ, after descending, find it necessary to return again, and thus the consumption of sound wood is greatly increased, for unlike biped and quadruped miners, the borer is compelled to find food where it is at work, and eats all that it excavates. On laying open the stem a number of curved markings, as in Fig. 6, Pl. iii, will be seen, which are the tunnels of the larva filled with its woody excrement. Sometimes these are so numerous as hardly to leave any sound wood, and, of course, the chance of the tree dying will be in proportion to the amount of damage it has sustained. When bored trees begin to sicken, the large red-ants are very fond of getting into them, and shortly clear out the borer's tunnels, not leaving a particle of the wood powder.* Trees in which this has taken place are sure to perish, as both air and water readily gain access to every part of the interior. The tunnels of the borer are very tortuous, but still so long as there is plenty of sound wood in the stem, it is a rare thing to see two of them touch the other, but as the wood gets gnawed away, they get so close, more especially in the middle of the tree, as not to leave an atom unconsumed. Accordingly, when the ants enter and clear out the debris, there is a great irregular jagged canal left, an inch or more in diameter. When a stem is recovering from the effects of the borer, the holes in the exterior are filled up by the first annual ring of new wood that is deposited, but the damage in the interior of the tree can never be repaired.

Is the Borer indigenous?—This is a question of great importance, and I have no hesitation in answering it in the affirmative. So far as historical evidence goes, it is in favour of this view, for many years ago a specimen of the beetle was got somewhere in Southern India by Chevrolat. I have also learned from good authority that it was well known nearly thirty years ago in native gardens amid the wilds of the Baba-boodens, into which it is impossible to conceive its having been introduced from any other part of the world. Indeed, so far as is known, it is peculiar to India, and this feature of its history, if confirmed by future observation, will put an end to all speculation as to how and whence it came. I have also observed it in stations so far remote from the coffee zone, as to preclude the idea of the insect having travelled over the intervening distance, and place it beyond doubt that it must have belonged to the local insect fauna. If further proof be necessary,

* They also kill the Borer.

it will be found in the fact of the borer having suddenly appeared in one season in so many districts of the country—districts separated by miles of forest and lofty hills—whereas, if it had been introduced, it would have appeared in one place merely and have gradually spread around that centre. So far as I am aware, the beetle of the borer has not been found in any indigenous tree, but that may, to a great extent, be accounted for by the circumstances, that it is difficult to discover whether or not a jungle tree is being preyed on by borers of this one's habits, and even when their presence is suspected, it is but rare that one can have the time and means to cut down and examine a large tree. In the orange and Grewia larvæ are found, which in appearance are identical with those of the Xylotrechus, and there is strong reasons for believing that they belong to it, as the shape and habits of the grub are very characteristic, and it is nearly the only member of its family truly apodous. I have found another beetle belonging to the genus Clytus, to which the borer was originally referred, in forest trees, but although the grub of it has a strong resemblance to that of Xylotrechus, it is at once distinguished by the fact, that it only attacks dead wood. It is not very common, but will sometimes be found in the stump of a Jamoon tree. As the borer belongs to the fauna of the coffee zone, it is not to be anticipated that it will ever disappear. Indeed, the occurrences of recent years would seem to show, that the conditions which favor its multiplication have been on the increase, and that, therefore, its permanent existence is on a safer footing than ever. These are, no doubt, unpleasant truths, but they are so supported by evidence from various quarters, that not a shadow of doubt can arise regarding them. It is also consolatory to know, that all sudden outbreaks of hosts of insects destructive to crops have disappeared or been reduced within moderate bounds, either suddenly or gradually, when left in the hands of nature; and there is no reason to suppose that the invasion of the terrible coffee borer will be an exception to the general rule. As has already, and as will hereafter be more fully shown too, a great deal can be done by the planter so as to render his plantation less liable to its attacks.

Causes that have rendered the Borer so numerous and destructive:—The causes that induce the undue multiplication of a species of insect, so as to render it a pest, are so numerous and obscure, as to render the subject one of the most difficult that can

engage the attention of the naturalist. An abnormal season, a particular wind, the disappearance of an insectivorous bird or predacious beetle, the introduction of a new plant or insect, the destruction of a particular plant on which some species used to feed, the sweeping away of forest and consequent disturbance of balance in the local fauna, the neglect or abandonment of cultivated land, and other circumstances of kindred nature, may each or all be the chief agents in calling forth hosts of noxious insects. In proceeding with such an inquiry then, as that of the borer pest, much cautious and patient observation is necessary, and the temptation to, and opportunities for speculation being great, conclusions reached *per saltum* must be avoided, and truth patiently worked out from facts furnished by nature. The first step must be to ascertain every thing connected with the habits and economy of the insect, which its size and other peculiarities render by no means easy, and as the time required by an individual to pass through the various stages of its life is often protracted, the observations must necessarily extend over a considerable period. The next object will be to ascertain what local peculiarities, likely to increase or diminish the insect, may exist, and with this view the meteorological history of the district must be scanned for any peculiarities of seasons, changes in local flora and fauna noted, and the geological features and nature of surface formations ascertained. I have made these remarks to show how the conclusions about to be given have been arrived at, and should they differ from those of others, the discrepancy will probably be found to have arisen from their having preferred the empirical to the inductive method of inquiry. Plants in a sickly condition, arising from poverty of soil, exhaustion from cropping, weedy ground, general neglect, or any other cause, are more liable to be attacked by insects than such as are in a more vigorous state. The moment a plant begins to flag, it becomes a fit field for animal and vegetable parasites. The former prey on its leaves, bark, or wood, greedily devouring them, while the latter draw on the juices of the plant, reducing them in quantity, and depriving them of important constituents. By unfortunate but inevitable sequence too, the presence of these parasites aggravates the very condition that invited them, and thus bad goes on to worse. In some instances the attacks of an insect are the primary cause of disease in a plant, but this is not the case as regards this enemy of the coffee tree. When plants, apparently healthy, become a prey to it, a careful

examination will either detect some obscure mischief, or they will be found in the neighbourhood of infested trees, where the chances of attack are greatly increased, the insect always working round a centre, and not apparently caring to undertake a long flight when it finds a coffee tree at hand. Assuming then that impairment in vigour is, as a rule, necessary to render a tree liable to suffer from the borer, it follows, as a matter of course, that the coffee plant throughout the whole of the coffee zone in Southern India must, of late years, have been more or less unhealthy, seeing that the insect has been so prevalent and destructive. There is no doubt, too, considering the vast tract over which it has extended, that this abnormal condition of the plant has been the result of some very general causes. The most obvious of these are the prevalence of a system of culture unsuited to the plant, and a neglect of the ordinary operations of garden management; but I believe that unusual atmospherical conditions, viz., a cycle of dry seasons, have had nearly, if not quite as great an influence in reducing the vital powers of the tree. At the same time, these droughts have rendered the insect infinitely more prolific, for it loves sunshine and a dry hot atmosphere, and many more of the eggs hatch in a droughty than in a moist season. In short, then, *inferior culture* and *unusual drought* have been the chief causes which have rendered the borer so numerous of late years. In inferior culture I include the absence of shade, as I consider that the neglect of it is of all things the most conducive to the increase of the borer. In Munzerabad, where shade is common, nearly every estate not so protected has either been completely destroyed or seriously damaged, while those under shade have suffered but very little. In the other districts, too, the comparative immunity of estates and gardens under sufficient shade is very remarkable. It is curious to notice in walking over an estate in which the protecting trees occur in clumps, the effects of the different degrees of shade, the plants which do not receive the direct rays of the sun being tall, green and free from borer, while those that are in bright light and exposed to the sun during a part of the day, are sickly or dead, and full of grubs and holes. In most cases the exact limits and shape of the shadow of a clump of trees is as accurately depicted by the state of the coffee, as if it had been drawn on paper by a sketcher's pencil. I have no doubt the great cause of coffee trees in shade escaping from borer is their superior vigour. Another reason is, that the

beetle dislikes shade and shuns it, the dim light, and the state of the atmosphere there being disagreeable to it, and unfavourable for the multiplication of its species. The other defects in culture have been fully noticed already. As a minor, but also potent cause of the great prevalence of the borer, I may mention *the cutting down of forest*, which has not only deprived the larva of its natural food, but driven away some of the enemies, which were wont to prey on and keep it in check. In the natural forest there is a beautiful balance between the various members of the fauna, and between noxious insects and their enemies, but when man steps in with his axe, all this is disturbed. It is a mistake, however, to suppose that insectivorous birds are frightened away by forest denudation. Some of the very few that live in dense forests in Southern India may have been so, but as a rule, they increase in clearings, and have undoubtedly done so on coffee estates. The causes, then, that have chiefly produced such a great increase in the borer may be briefly summed up as follows—*drought, want of shade, bad culture, destruction of forest trees in which the insect used to live, and departure of some of its enemies.*

VI.—HISTORICAL ACCOUNT AND STATISTICS OF THE RAVAGES OF THE BORER.

The manner in which insects that prey on cultivated plants suddenly appear in devastating hosts, and again disappear or decrease, is truly marvellous. Of such occurrences, the world's history furnishes us with numerous examples, the invasions of the locust being, perhaps, the most familiar and terrible. The raids of this insect are chiefly confined to the African Continent and European countries on the shores of the Mediterranean, but the Southern Mahratta country was many years ago ravaged by a red locust, which appeared in a column hundreds of miles long, and so dense that it completely obscured the sun.* In the case of the locust and some other insects, it is the imago that proves destructive, but more frequently it is the larva, insects in that stage being most voracious,† while their numbers‡ more than compensate for their limited

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* Kirby and Spence, p. 127.

† See Westwood's Entomological Text Book, p. 189.

‡ But a very small number of larvæ attain the imago, or perfect stage, their foes, in the shape of other insects and birds, being innumerable.

powers of locomotion. A notable instance of the destructive powers of a grub was exhibited in the case of the *Hessian Fly* (Cecidomyia destructor) in America, its depredations having nearly exterminated and put a stop to the culture of wheat over a large tract of country. In England, there is the Wire-worm (Elater lineatus) so fatal to grass and cereals, and a countless array of caterpillars that prey on the monarchs of the forest, the shrubs on the lawn, and every kind of farm and garden produce. In France, the caterpillar of a small moth (Tortrix vitana) does incalculable injury to the vines, and some years ago in the West Indies, and in 1856 in the Mauritius, the caterpillar of a white moth, (Phalæna saccharalis) proved so destructive to sugar-cane plantations, as almost to put a stop to that branch of industry. The larva was called the *Cane borer*, from its habit of boring into the canes, where it committed such havoc as to completely destroy them in a very short time.* The insects called borers, that in the larva state, live in the interior of woody stems, are very numerous. A few of them belong to the Lepidoptera, such as the Goat-moth caterpillar which destroys the stems of English forest trees, the grub of one of the Hepialidæ that tunnels our charcoal tree (Sponia Wightii), and the " Red borer" (Zeuzera), so well known to the coffee planter. The majority of borers, however, belong to the order of beetles, and are very numerous and widely distributed. Fortunately they do not, as a rule, attack living wood, although to this there are numerous exceptions. A serricorn beetle, the Lymexylon navale, is in the larva state very destructive in the oak forests of the north of Europe, and at one time did great damage in the dockyards of Toulon. Many years ago it appeared in devouring hosts in the Royal dockyards of Sweden, and Linnæus having been consulted on the subject, advised the submersion in water of the timber at the season when the insect was depositing its eggs, a measure that effectually put a stop to its depredations. The longicorn family of beetles undoubtedly yields the largest number of ligniperdous species, the larvæ of the Prionidæ and Cerambycidæ being especially destructive, and well known both in Europe and India. Some years ago Lamia sentis did considerable injury to soft-wooded trees in Bombay,† and of late a borer that attacks the Casuarina tree about Madras was presented to the Entomological Society by Dr. Cleghorn, and recog-

* Westwood Gard. Chron. 1856, p. 453.

† Journal of Royal Asiatic Society of Bombay, vol. i., p. 136.

nised as the Cerosterna gladiator. In the New World the Clytus speciosus commits terrible havoc in the valuable sugar-maple trees and the Clytus pictus is not less destructive to the Locust-tree Robinia pseud-acacia.* It would be impossible, as it would be useless to allude here to all the insects that prey on cultivated plants, but it is important to note that in every instance in which a noxious insect has suddenly increased so as to become a pest, the invasion has rapidly or gradually declined when left to the hands of nature, who has her checks in other members of the animal creation, and destroying agencies in sudden changes of temperature, deluges of rain or the dread tempest.† It may be safely said that every plant in nature has its special insect foe, some tiny creature that feeds on it, and that when that fails, or proves insufficient, the insect resorts to some other of an allied description. Were it not so the coffee shrub, which is an exotic in most countries in which it is cultivated, might be free from such marauders, but instead of that, it seems to encounter a special host of indigenous insect enemies in every land to which it has been transported. Mr. Neitner in his " Enemies of the Coffee tree in Ceylon," describes twenty insects that prey on it, and says that this list " might easily be doubled." Porter in his " Tropical Agriculturist" mentions two that attack it in the West Indies, probably a *Saw Fly* and the *White Bug;* and Kirby and Spence (Introduction to Entomology) speak of the larva of a little moth that ravages the plantations in Guadeloupe. In Agassiz's " Journey in Brazil," we are told that coffee plantations often look ragged and thin from the ravages of a Tinea, which spins its cocoon on the leaf, and that the Suaba ants (Ecodoma cephalotis) also do immense injury to coffee, by cutting out patches from the leaves. Of all the enemies of the coffee plant in the east, the bug (Lecanium coffeæ), was, until the borer appeared, the most prevalent and the most destructive; but since the latter grew so numerous, the former has come to be looked on as a minor evil, as it merely damages, while the other, as a rule, kills the subject of its attack. The larva, called the borer, has

* Treas. of Nat. Hist. (1862), p. 135.

† At one time Formica Analis, an ant, proved so destructive to the sugar-cane in Granada, as to put a complete stop to its cultivation. A reward of twenty thousand pounds was offered to any one who would discover an effectual mode of destroying it, but no remedy was found until Providence sent a tempest of rain and wind which annihilated the destructive hosts.—*Kerby and Spence,* p. 102.

for many years been known on coffee plantations in Southern India as the *worm*, and the beetle as the *coffee-fly*. A rather curious feature in the history of the insect is, that it does not attack the coffee tree in Ceylon, although existing in jungle trees there, and I think we may safely infer from this circumstance, that our coffee tree, which is exactly the same species as that grown in Ceylon, must, as already stated, have been in an unhealthy condition to render it liable to the depredations of the borer.

Nuggur :—In Nuggur the borer has been noticed for about thirty years in the gardens that belonged to Baba-booden, but it does not, for fifteen or twenty years subsequently, appear to have multiplied to any extent, and only attacked worn out or drought-exhausted trees. Within the last nine years it has become very numerous, appearing wherever there has been coffee to consume, and attacking trees of all ages unprotected by shade. On one estate, in 1860, in which the shade trees had here and there died out, some 60,000 plants were destroyed, and taking the whole district, the mean loss cannot be less than five per cent. Of late, the scourge has been on the decline, most of the weakly and exposed trees that suffered from it having died out and been removed. The alarm regarding it is also subsiding, it being found that well-shaded trees rarely suffer or die.

Munzerabad :—In this district Europeans state that they have noticed the borer for about twelve years, while maistries and native planters profess a knowledge of it for fifteen or twenty years. Here, as in Nuggur, it has become much more common within the last eight or ten years, and for three or four years its ravages have created great anxiety. Taking the whole district it may be said, that the loss has been nearly in exact proportion to the degree of exposure of the plants to the direct rays of the sun, and such being the case, all alarm has nearly subsided, the planter feeling that in shade he has a nearly perfect preventive. The epidemic has undoubtedly been most severe in dry eastern situations, but there is not an estate in the district on which the insect has not made its appearance. One singular case of immunity came to my notice in an estate lying far out to the west amongst the crests of the ghats, and unprotected by shade. It was situated in a ravine opening to the south west, and all the trees showed symptoms of having to fight a hard battle with the monsoon. To this, however, I attribute its safety from borer, the severity of the

climate being such as to deter or destroy the insect. Of European property in the open, about fifteen hundred acres have been nearly completely denuded of coffee, and what remains is of comparatively small extent, and far from promising. On estates under shade the loss varies, being almost *nil* where the protection is sufficient, and ranging from three to four per cent. when it is less so. In some cases, where attempts were made to cultivate under sparse shade, with the view of securing some of the advantages that attend culture in the open, the destruction has been very heavy, averaging from twenty to thirty per cent., and, in others in which artificial shade was reared some time subsequent to the planting of the coffee, it varies from eight to ten per cent. Taking the whole of the properly shaded coffee in the district, the mean average loss would amount to about three per cent., and in addition to this, probably about five per cent. of trees have been injured by the borer, but are still alive and likely to recover. On native estates, the loss has been somewhat heavier, ranging from three to five per cent., and a fair average for the whole would be about four per cent.; while of injured trees likely to recover, there would be from six to eight per cent. The greater damage sustained by this class of property is easily accounted for, by the inferior style of culture generally followed by native owners. Adopting these estimates then, the mean total loss on all shaded estates in Munzerabad amounts to 3·5 per cent., and as will presently be seen, is very small in comparison with the damage sustained in other districts.

Coorg :—In Coorg the borer has been noticed more or less during the last twelve years. It first made its appearance in the hot lateritic districts of Southern Coorg, but for some years did not attract much attention. In 1865, it spread to other parts of the district, and in 1866, it multiplied as if by some miraculous power, appearing everywhere, and exciting general anxiety. In the spring of 1867, the mortality amongst trees was so general, sudden, and extensive, that many anticipated the complete extirpation of the plant, and with ruin apparently staring them in the face, could no longer conceal their fears. From time to time accordingly, various communications appeared in the columns of the local papers, giving gloomy accounts of the state of affairs, and anxiously enquiring after some means that would enable the planter to destroy this tiny but terrible enemy to his crops. As might have been expected, a good deal of crude advice was offered. Some of the remedies pro-

posed were manifestly absurd,* and others impracticable on the large scale, so that, on the whole, these appeals did not elicit much really valuable information. In the month of October 1867, the attention of the Supreme Government was attracted to the subject, and as the sandalwood in Coorg was also said to be suffering from the ravages of a borer, it was deemed necessary to order a special official investigation.

Dividing Coorg into two districts, as naturally divided by the Cauvery, the greatest damage from the ravages of the insect has been sustained in the Southern division, the land under culture there being generally lower, and the climate hotter than in the northern section. In the tract to the west of Veerajpettah, sweeping round from Periambady, the loss has been very heavy, ranging from five to sixty per cent. On the other hand, the estates on and near the Periambady Ghat road have escaped in a remarkable manner, but a very few bored trees having been found prior to the date of my visit in December. All of these lie on the immediate western flank of the great mountain chain, where they receive the monsoon with unbroken force, and are swept with strong chill winds throughout the year. To these peculiarities they doubtless owe their safety, the climate, as in the case of the estate similarly located in Munzerabad, being such as to destroy or keep away the beetles. In estates to the east of Veerajpettah, in the bamboo district, the epidemic has not generally been very severe, although one, the oldest in the district, has been all but completely denuded of its trees. Taking the whole district of South Coorg—good and bad together—the mean loss amounts to fourteen per cent. In the northern half, the insect has been most destructive on estates lying east of Mercara, where, as already stated, the rainfall is much less, and the air hotter and drier than towards the west. Taking the whole of this division, the loss ranges from one to ninety per cent., the mean being about seven per cent.,† or one-half that in South Coorg. We have thus on European property, throughout the whole province, a mean loss of no less than 10·1 per cent., and besides this, about fifteen per cent. of trees have been more or less injured, of which about three per cent. may yet be expected to perish. In some native gardens on the bare exposed

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* Such as fires and lanterns, &c., smeared with adhesive substances to catch the beetles at night, although they are diurnal in their habits !

† The reason for the mean being so low in North as compared with South Coorg, while the extremes are so wide apart is, that estates are much more numerous in the former, and the average was on most of these much lower than on those in South Coorg.

slopes about Mercara, the plants have been almost entirely annihilated, and the general loss on native property in that quarter ranges from fifteen to fifty per cent. In the portion of North Coorg, between Mercara and the Cauvery, it has been much less, most of the gardens there being under natural shade. In South Coorg too, most of the native gardens are under shade, and where this has been perfect, the loss has not exceeded five per cent. In many instances, however, the forest trees had from various causes partially died out, and in all such the loss has been very heavy, the extermination being generally complete where there was no protection.* Part of the native property in Coorg being thus entirely or partially in open ground and part in shade, it would, for statistical purposes, be useless to give the mean loss in the whole collectively.

Wynaad:—For the last fifteen or twenty years the *borer* has been known in Wynaad under the name of the *worm*, and the beetle as the *coffee fly*. So long ago as 1853, one estate in the bamboo district was rendered utterly worthless by the ravages of the insect, but generally speaking, although widely diffused, it was not very destructive, or if it did prove so, as in the above instance, it confined itself to one estate or corner of a district, and having done its work, the invasion subsided. Although the Wynaad planter has thus had a longer acquaintance with the borer than those in any other quarter, still its presence does not, until about four years ago, when its devastations began to be very extensive, appear to have excited the slightest alarm. Trees bored down to the roots were removed, while the stems of those less injured were cut down to the sound wood, and as the losses on a large estate for years in succession rarely exceeded a few score trees per annum, no one suspected that this tiny enemy had the power of multiplying to such an extent as to become a scourge and a terror. It was, indeed, considered as one of those inevitable minor evils from insect voracity, which every cultivator of the soil has to endure patiently, and accordingly no special remedy was ever thought of beyond the simple expedient just mentioned. In 1865, however, the increase in the number of bored trees began to attract general attention, and planters at their gatherings were wont to compare notes on the sudden multiplication of the *worm*. In 1866, rumours floated about that various properties in dry easterly localities were being decimated by the pest, and as it was undoubtedly on the increase all over the

* Trees originally cultivated in shade suffer much more from borer when deprived of that protection, than those cultivated throughout in open ground.

district, there sprang up a general feeling of alarm. In 1867, the larva appears to have first been called the "Borer," and so general and extensive was the destruction going on, that the name travelled far beyond the range of the district, and every planter felt called on to brace up his energies, and seek to overcome an enemy that threatened to annihilate his crops. To many the question arose, "Can we continue to cultivate coffee in Wynaad, or are evil days come upon us, such as befel the nutmeg planters in Singapore?" The dismay that such a state of matters created can be better imagined than described. Here was a number of men, many with large pecuniary interests at stake, threatened with complete ruin, after enduring for years the pains of exile, a toilsome lot and many hardships, that they might be able to go back to their native land with a competency. To bear up under such adverse circumstances, and to carry on the struggle in silence, must have required no little moral courage, and we give the planters of Wynaad credit for exhibiting that quality in a high degree, as they hardly uttered a word of complaint during a cycle of disastrous years. The district is divided into

North-west,
South, and
South-East Wynaad.

In North-West Wynaad, the destruction by the borer seems to have been most extensive around Manantoddy, and in bamboo land towards the frontier of Coorg. Some properties lying near the Mysore road have been completely denuded, nothing remaining but here and there a dry skeleton stump; and even these have in some instances disappeared, and the ground become covered with scrub jungle. Some old estates to the west have also suffered heavily, the loss in several instances being quite fifty per cent. Towards Periah, and on estates to the north of Manantoddy, the damage varies very much, ranging from less than one to fully fifteen per cent., and the total mean loss in North-West Wynaad would be from eight to ten per cent. A curious example of the effect of shade as a preventive of borer exists in the Club compound at Manantoddy. The club-house stands on the apex of a conical hill, which a few years ago was covered with thriving coffee trees, but at the present day all these have disappeared, except a few rows on each side of the road, well shaded by fine Jack trees, and the plants thus remaining are not only alive, but green and flourishing. A better proof of the efficacy of such protection could hardly be desired, and it seems almost as if

the incident had taken place in such a conspicuous place, for the express purpose of teaching all comers a lesson. The native gardens in North-West Wynaad are partly in the shade, and partly in the open, and, as a rule, the destruction in them has been very heavy, certainly on an average fifteen per cent. In South Wynaad the losses have been heaviest out towards the bamboo district, but all parts have suffered more or less. The average per-centage of loss, however, is somewhat less than in North-West Wynaad, and does not probably exceed five per cent. In South-East Wynaad the per-centage of loss is found to increase the farther the estate lies to the east, and in some quarters the destruction has been complete, or will certainly be so at no distant date. On the whole, estates in this quarter have suffered quite as much, if not more, than those located in the northern part of the district, and I reckon the general loss about ten per cent. Taking the whole district of Wynaad, the mean loss would be about eight or nine per cent., or slightly less than in Coorg.

CHAPTER VII.—PREVENTIVE AND REMEDIAL MEASURES FOR THE RAVAGES OF THE BORER.

The application of means to destroy the borer, or prevent its attacks is, owing to some peculiarities in its habits and economy, rendered very difficult. In the case of the sugar-cane borer already referred to, the planter was able to collect and destroy the insect in the chrysalis stage, as it was then attached to the leaves of the plant, but the coffee borer lives both as larva and pupa in the interior of the stem, and can only be reached by cutting down the tree. To this measure there would be no great objection, provided the enemy appeared in limited numbers, but unfortunately it is generally so numerous, that to cut every infested stem would be tantamount to the destruction of more than half the trees on an estate. Again, in the case of insects of nocturnal habits, the numbers may be rapidly diminished by displaying lights, to which they readily fly, and having some simple contrivance to secure them when under the influence of this *glamour*. But the borer beetle loving the day and bright sunshine is proof against any such lure, and even saccharine sweets, which few insects can resist, and which are readily made the means of their destruction, have for it not the slightest attraction. The fact, too, of the beetle appearing in nearly every month of the year, coupled with its small size and active movements, render any

attempt to secure it by day amongst the trees rather difficult. On the slightest alarm it drops on the ground, and it requires sharp eyes and nimble fingers to pick it out from amongst the weeds or loose earth. In the further consideration of this subject, I shall first notice remedial, and thereafter preventive measures.

Remedial measures:—The number of these which has been proposed is very great, but I shall only notice such as are of a really practical nature, and of which the majority have been tested by experience. The female beetles, it will be remembered, deposit their eggs in the cracks of the bark, and are most abundant just after the rains, and about the middle of the hot season. At this period of its existence, therefore, the enemy is to a certain extent in the power of the planter, as he may in various ways attack the ova. One very common and successful expedient has been to remove all the outer cracked layers of the bark from the stem, and in doing so, the eggs are either crushed or rubbed off. This operation may be performed either with a piece of curved iron with a blunt edge, or, better still, with a bit of rough coir rope passed once round the stem, and firmly pulled first in one direction and then in another by a coolie holding an end in each hand. There is some risk attending the use of the iron scraper, as, if not closely watched, the coolie will often remove the entire bark. On the whole, therefore, the coir rope is perhaps the better implement of the two, although with it it takes a little more time and exertion to get through the work. Another way of getting rid of the ova is by the application of some fluid that will destroy their vitality. A very effectual wash for this purpose may be made, by mixing slaked lime, that has for some time been exposed to the atmosphere, and sal ammoniac in hot water. The latter is procurable in every bazaar at a very moderate cost, and is called in Tamil *Navacharum*, and in Hindustani *Nowshader*. The proportions are two parts of old lime, one of sal ammoniac, and eight of boiling water. Mix and stir well until nearly cold, and then add twelve parts of cold water, and apply grounds and all freely to the stems, daubing into the cracks with brushes, which may be made from the leaf stalks of the cocoanut tree. A weak solution of carbolic acid will also have the desired effect, and as it is made from, and has the smell of coal tar it has the advantage of being most offensive to the beetles. It may be used in the proportion of one part of acid to thirty of water, and should also be well rubbed in so as to penetrate every crevice. The cost in England of the brown commercial carbolic acid is about two

and a half rupees per gallon. Coal tar diluted with fish-oil may also be used, and this mixture not only destroys any ova that may have been lodged, but forms a mechanical covering highly offensive to the beetles. I think it highly probable too, that a moderately strong solution of common brown salt would prove destructive to the eggs. When the larvæ have once entered the stem, no external application will of course be of the slightest value, but if the injured trees are not too numerous, they should be cut and burned immediately, so as to destroy the colony in the interior. The coolies very soon learn to distinguish a bored tree by its peculiar appearance, and should be instructed to test the stem by giving it a sudden wrench, when, if infested with borer, it is sure to snap across at the point where most injury has been done. The next point to ascertain is, whether the insect has extended its depredations to the roots, and if so, it should be dug up. If safe, the root may be left, the stem being cut across below the fracture with a saw, so as to leave a clean wound. Such a stump generally throws up a number of suckers, which should all be allowed to grow for some months, and then the strongest one may be selected and kept, and the others cut away. If all the suckers, save one, are cut down from the first it grows too rapidly, and being tender, rarely survives the hot season. This weeding out of trees containing the insect is of all remedies perhaps the most effectual for borer, but of course it can only be put in practice when the bored trees are not very numerous. When more than thirty per cent. are attacked, it is better perhaps to let the trees remain, as matters can hardly be worse, and there is a chance of many of them recovering. At the same time, no pains should be spared to render the trees as vigorous as possible, as they will thus be enabled in many cases to recover from the effects of the injury they may have sustained.

Preventive measures :—The value of shade in protecting coffee from the ravages of the borer has already been so fully discussed, that it will be unnecessary to say much more on the subject here. It is only on young estates, generally speaking, that it can be made use of, as the trees are difficult to rear on land long under culture, and take so long to grow, that in all probability the coffee will be destroyed before they are of any service. On old estates in open ground, then the planter must trust more to other resources, and nothing will be of greater service than regular manuring, digging and weeding, and careful pruning and draining. In short, *high*

culture. At the same time the stems may be protected in various ways, so as to render it impossible for the beetle to find any place suitable for the hatching of its eggs. Observing that in young trees the ova are generally deposited not far from the base of the stem, some planters have drawn up the earth around this, in hopes that it would keep the enemy at bay, but this expedient is not very successful, as when a female alights on a tree, she will attack the upper portion of the stem on finding the lower inaccessible. A mixture of cow-dung and clay, such as that used by natives for smearing the floors and walls of their houses, may however be applied with advantage. It should cover every portion of the stem, and if carefully put on, will last through the monsoon, except in very exposed places. A very good compost for coating the stems may be made as follows :—

One basket of fresh cow-dung.
Half a basket of quick lime.
A small quantity of wood ashes.

Mix with as much soap-suds (country soap) and water as will make it of the consistence of a thick paint, and apply with the cocoanut brushes. Lime wash is also a very good application, but apt to scale off when the plant is shaken by the wind, and to be washed off by rain. Covering the stem with moss will also afford efficient protection. It should be laid on about two inches thick and secured with bands of fibre, and if applied about the beginning of the monsoon, will live and become firmly banded in its new position. Sometimes, when debarred from the stem, the beetle will lay its eggs on a stout branch, but this is not common, and does not do a great deal of harm. As regards estates in shade, care must be taken to supply the place of trees that may perish, as whenever a sunny opening occurs, the enemy takes advantage of the breach, and at once becomes master of the position. Manuring, &c., must also be just as carefullly attended to as in estates in open ground.

CHAPTER VIII.—FRIENDS AND FOES OF THE COFFEE PLANT.

In every tract of forest or land in a state of nature, a due balance is maintained amongst the various plants and animals that live there, so long as there is not any disturbing cause, such as clearance or culture. Whenever such takes place, the law that

secured this balance by a war of species is upset, and but too often noxious kinds, being no longer held in check multiply in an extraordinary manner. When the land is cultivated, a thousand noxious weeds contend with the crops for possession of the soil, and hordes of creatures that prey on them appear on the scene. It is interesting to note, however, that even when man thus sets himself up as master of the position, nature still tries by various agencies to keep destructive creatures within due bounds, and indeed but for such aid, he would at times be driven vanquished from the field. Thus the increase of insects destructive to coffee, has been followed by an increase in insect-eating birds and reptiles, and the good that these effect can hardly be over-estimated; for a pair of birds, with a nest full of hungry *crops*, will probably destroy more insects in a day, than twice as many coolies sent to catch and kill. It is not my intention to notice all the animals that directly or indirectly are friendly to, or prey on, the planters' trees and crops, but only such as are most remarkable from the amount of good or ill that they do.

FRIENDS.

Mammals.

Mungoos:—This creature (Herpestes griseus) holds rather a dubious position, inasmuch that although a stern foe to the coffee rat, it also destroys some of the planters' best friends, such as lizards. Its presence, however, is generally encouraged on estates, with the view of destroying snakes.

Birds.

The birds that prove friendly to the planter, by destroying insects, &c., are so numerous, that only some of the more common ones can be mentioned. As already stated, some species of birds, especially the insectivorous, have become more numerous as clearings have been extended, simply from the circumstances that food supplies have become more abundant, and because they prefer the coffee estate, with its convenient bushes and rows of roosting trees, to the dense jungle.

Owl.—Of these, two species, belonging to the genus Syrnium, inhabit the patches of forest near coffee estates, and sally forth at night to prey on rats, mice, &c. The one is the "Brown wood owl," and the other the "Mottled wood owl," of which the former seems the more common. They are great friends to the planter, inasmuch as they kill the "coffee rat," but are objects of horror to the coolies, who have various superstitious ideas regarding them.

The Jay, or Indian Roller :—Is not unfrequently seen in the bamboo district, and is busy all day long picking up grasshoppers and beetles. He perches on some fire-scathed stump or tree, and on seeing an insect on the ground or a bush, swoops down on it with unerring aim.

Woodpeckers :—Various species of these inhabit the jungles surrounding coffee estates, where they live mostly on the larvæ and pupæ of insects found beneath the bark and in the wood of trees. They are very shy birds, but I have found traces of their presence in remote corners of coffee estates, when they had come to feed on the larvæ and probably the beetle of the borer.

Crow Pheasant, or common Concal :—This bird (the Centropus rufipennis) is very common, particularly on the eastern margin of the coffee zone. It feeds on the ground and on bushes, and lives on insects and small reptiles. Its ally, the *Cuckoo*, is also insectivorous, but not common enough to require special notice.

Sun Birds, &c. :—Several of these frequent the forests in Wynaad and Coorg, but they are not common. The one seen most frequently is the *Purple Honey Sucker* (Arachnechthra lotenia). All of them eat small insects found in the flowers, or on the leaves of bushes and trees. One or two *Nuthatches* also frequent the coffee districts, but they seem rarely to leave the jungle.

The Hoopoo :—This bird (the Upupa ceylonensis) is common on clearings, and walks about under the coffee bushes, picking up beetles and various large and small insects.

Shrikes :—This family, of which several species frequent coffee clearings are all insect-eating. The (Dircrurus macrocercus) *King-crow* is the one most commonly seen, and is constantly engaged either on the wing, pursuing moths, butterflies, and dragon-flies, or on the ground, hunting for beetles and grasshoppers. The *Black Drongo* (Edolius malabaricus) is also a famous hunter, and may often be seen on bamboo and other low jungles near coffee clearings.

Bird of Paradise:—This beautiful creature (Tchitrea paradisi) is often seen in sparse jungle, gliding about from tree to tree, with its long white tail sailing behind. It catches insects on the wing. Several *Fly Catchers* also exist in the coffee districts, and live mostly on very small insects which they catch on the wing.

Thrushes:—Several of these voracious insect-feeders are found in Wynaad, Coorg, and Mysore. One, the (Myiophonus Horsfieldii), *Whistling Thrush,* is well known on account of its peculiar notes, which seem to come from a man trying to whistle some tune of which he has an imperfect recollection. The *Blue Rock-Thrush, Ground-Thrush,* and *Black-capped Blackbird* are also not uncommon, and particularly industrious in picking up caterpillars, beetles, and all kinds of insects.

Mynas:—These birds have increased very much of late in coffee estates, appearing in large flocks, and proving of immense benefit to the planter from the number of insects of all kinds which they devour. The kinds seen belong chiefly to the genera Acridothens, and Temenuchus. The *Hill Myna* (Eulabes religiosa) with its yellow wattles is very common. It eats the seeds of various noxious weeds, and I am inclined to think does not disdain an insect when a tit-bit comes in its way.

Sparrows:—The common impudent house-sparrow (Passer Indicus) has become numerous of late years in Coffee estates, but probably migrates to the east during the rains, as it loves a dry coat and quarters. It lives on seeds and insects, and has an insatiable appetite.

Larks:—At least one *Bush Lark* (Mirafra) and one *Tree Lark* live in the coffee districts, and prove very destructive to insects.

Peacocks:—This beautiful bird (Pavo cristatus) is very common in some of the planting districts, more especially in South-East Wynaad and Mysore. It is, however, sadly persecuted, the jungle tribes catching it with snares, and the sportsman killing it with his gun. It is fond of grubs and beetles, and even devours small snakes and other reptiles.

Jungle Fowl and Spur Fowl:—The *Jungle Fowl* (Gallus Sonneratii) and Spur Fowl (Galloperdix spadiceus), more especially the former, are extremely common in the coffee districts, and may often be seen in the early mornings running on the paths and between the rows of trees on estates. They are both very fond of insects,

and instead of being shot down and frightened, should be encouraged as staunch friends to the planter. *Quails* (Turnix) appear to be on the increase, frequenting little spots of jungle and grassy patches on coffee estates.

Reptiles.

Lizards :—In the list of friends, the lizards are rather conspicuous, on account of their numbers and voracity. They have, like some of the birds, undoubtedly increased as the jungles were cleared away, and destroy immense numbers of insects. Beautiful green and striped lizards are very common on coffee estates, and several species of Calotes may be seen hanging on to the branches and looking out for beetles, which their powerful jaws enable them to crush with ease.

Snakes :—Of these the *Rat Snake* (Coryphodon) is a great friend to the planter, and should never be molested or destroyed. He is a most indefatigable enemy of the coffee rat (Golunda Ellioti) which has in some seasons proved very destructive, appearing in thousands, and gnawing off all the tender wood from the trees. The other snakes seen on coffee estates hold a very dubious position as regards their services, being but too ready to prey on the friendly lizards and toads. A very interesting experiment in the way of checks is being conducted by Mr. Thomas, Collector, Mangalore, who has sent snakes and mongooses to the maritime islands in his collectorate, to keep down the rats, which are so numerous that the inhabitants are obliged to organise monthly hunting parties for their destruction.

Toads :—The members of the despised, dreaded, and persecuted family of Batrachians (Bufo) are staunch allies of the planter, as they are very fond of insects, and are very expert in catching them.

Insects.

Amongst insects the coffee has many foes, and so far as I know, hardly a friend. When the tree contains borer, the large pugnacious red ant sometimes enters it from below, removing the debris of the wood from the tunnels, and killing and eating not only the larva, but even the beetles. Although the tree is thus freed its enemy of the borer, the clearing of the tunnels is of dubious benefit, as it permits the air and rain to enter more freely, and hastens the decay of the stem. This species sometimes build their nests amongst the offee, but are an intolerable nuisance, being most irascible and biting with the utmost fury the naked bodies of the coolies. Some

jungle tribes and coolies, however, eat them, seizing them in handfuls and chewing them on the spot!

Spiders.

There are several species of net-weaving spiders found on coffee estates, belonging to the genus Epeira, which would be quite capable of killing, and no doubt do destroy borer beetles or moths when they get entangled in their snares. A large and ferocious Mygale is also not uncommon, making his den, a burrow six or eight inches deep, in the scarps of the roads. Outside there is a little funnel-shaped expansion of silken network, with a hole large enough to admit the finger. On digging away the earth, the burrow is found lined throughout its entire length with this beautiful web, which is of considerable strength, and very close in texture. At the extreme end the hole enlarges into a small chamber, in which the creature hides itself during the day. If disturbed it gets irate and shews fight, and so hideous is its appearance, that I have never had the courage to touch one with the naked hand. It is nocturnal in its habits, and preys on caterpillars, moths, and beetles.

FOES.

The enemies of the coffee are very numerous, and it will only be possible to notice some of the more notable amongst them.

Mammals.

Monkeys :—Several species are found in the coffee zone. The *Black Neilgherry Langur* (Presbytes jubatus) sometimes appears on the borders of estates near the crest of the ghats, but is shy and does little damage. The Inuus Silenus, dark in colour, and bearded like the Ceylon Wandaroo, is rather widely distributed, but prefers tall jungle to a coffee estate. The large grey monkey (Macacus) is most numerous, and is a great pest on shaded estates in Mysore. It lives in the large trees, and is very wary, retreating on the slightest disturbance to the topmost branches and concealing itself amongst the foliage. It eats an immense quantity of coffee, as the fruit gets ripe, does not despise the young leaves when hungry, and breaks and injures the branches by climbing and jumping about upon them. Large numbers of them are shot, but they appear to multiply very

fast. They merely eat the pulp of the fruit, spitting out the seeds. Coolies are fond of their flesh, which is said to be any thing but disagreeable.

Jackal:—This animal (Canis aureus) would appear to be omniverous. On the plains, near villages, it preys on sick goats or sheep, and does not despise the vilest carion, and in the coffee districts it greedily devours the ripe coffee berries. The beans pass through its intestines uninjured, and indeed they are said to be rather improved by the process, acquiring a particular goût, highly relished by connoisseurs! There seems to be no method of getting rid of them, except by poison distributed in the body of any dead animal.

Rats:—The *Coffee Rat* (Golunda Ellioti) is at times a terrible pest, and is rather curious in its habits, appearing in myriads one season and then disappearing for years. This no doubt arises, as the natives suppose, from its being migratory, so that when the food supplies get scarce in one quarter, it moves away to another district. Its ordinary food is the seed of the bamboo and various jungle plants, and it probably only attacks the coffee, when these are not procurable. The natives of Ceylon say that it usually lives on the *Nilloo*, a Strobilanthus, and that this blossoms once in seven years, and then dies; an occurrence which, by depriving the rats of their ordinary food, sends them forth to spoil the coffee estates. Curious to say, some of the natives of Coorg have a somewhat similar story. Their belief is, that the bamboo seeds generally only once in sixty years, and that the abundance of food in that season causes the rats to multiply to an enormous extent. Thereafter, when the whole of the bamboo *rice* has been eaten up, they are obliged to attack the coffee or any other plant on which they can feed. The bamboo rat, when plundering a coffee estate, lives during the day amongst the roots of the nearest bit of jungle, and sallies forth at night from this retreat. It does not appear to touch the berries, but eats tender buds and succulent shoots, and chews the bark of young wood. To get these it climbs the tree, and walking out on the branches, divides the twigs with its sharp incisors, as clean as if they had been cut with a pruning knife. It then descends, and either feeds on the spot, or drags away the spoil to its hiding place. When the plants are very young, it sometimes gnaws them off a few inches above the ground. Various means have been tried for getting rid of rats, but they are in general so numerous, that the few hundreds

killed by poison or trap are as nothing compared with the hosts that remain to carry on the work of destruction. Some years ago field-mice became very numerous and destructive in the New Forest in England, and after every ordinary device had been tried in vain, were caught by means of pits dug in the ground, very much broader at the bottom than the top, so that when the creatures in their peregrinations fell in, they found it impossible to get out again.* Possibly this plan would prove effectual in the case of the coffee rats, as it is nearly impossible to get them to touch poison, and they have an instinctive dread of, and avoid all common traps.

Squirrels:—The *Brown Squirrel* and the common *Grey* eat the coffee berries, but the damage they do is very inconsiderable.

Buffaloes and Bullocks:—These rarely touch the leaves of the coffee, but by brushing against the branches they frequently shake down the fruit. Buffaloes, too, have a nasty habit of rubbing against, or even rolling over on the trees, by which the branches and sometimes the stems are broken and smashed. The amount of injury done in this way is in some districts very great, as the owners of the cattle generally drive them out into the jungle, and allow them to range wherever they please. Bullocks also break branches by making rubbing posts of the trees, but are most destructive where the charcoal tree or jack is being raised for shade. They are extremely fond of the leaves of these, and in the hot season, when grass is scarce, whole herds rush down on estates, and in a few hours utterly destroy hundreds of saplings, by eating off the tender tops and side branches. In the case of cattle trespass, the planter is very rarely able to obtain redress, as the animals are nearly as wild as the deer of the forest, and most difficult to catch or identify. When pursued, they only do more damage by running over the trees, and gaining the boundary of the forest disappear and are lost amid its recesses. Nothing but a dense rose, or other prickly hedge, will keep out these marauders, and if it has one weak point, they are pretty sure to discover and take advantage of it to gain admission. In several districts, such as Coorg, the nuisance of cattle trespass has become so great as to be almost intolerable, and to put a stop to it, some modification of the present law seems desirable. In every case in which the cattle are caught or identified, the owner should be summarily punished with a fine heavy enough to make him dread

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* London's Encyclopædia of Gardening, p. 1154.

its repetition, while every facility should be given for the recovery, by a civil action, of damages according to the injury done.

Insects.

As stated already, a great many insects injure the coffee tree, but it would be out of place to notice any here, except those which are of some importance. The destructive species belong to the orders Coleoptera, Orthoptera, Lepidoptera, and Homoptera, and one remarkable feature with regard to them is their wide distribution in a north and south direction, nearly all of them being found in every part of the coffee zone. This may be accounted for by the uniformity in physical conformation, flora and climate, that characterizes the track, and by the absence of any natural barrier to migration, such as a transverse lofty mountain range, or wide gap in the ghat chain. To the west, these insects can hardly be said to extend beyond the crest of the ghats, the lofty peaks that rise here and there, and the abrupt descent and rapid change of flora and climate on the western face having proved insuperable obstacles to their proceeding in that direction. To the east, their range is greatly more extensive, the descent here to the table-land of Mysore being very gradual and unobstructed. In several instances I have found the Xylotrechus, thirty miles beyond the eastern margin of the coffee zone, and so far as climate and elevation go, there is nothing to prevent its living in any part of Mysore. Judging from its habits, there is strong reason for believing that it was originally a tenant of the dry jungles, that prevail towards and beyond the eastern frontier of the coffee districts.

Coleoptera.

The chief of these, the notorious white borer, Xylotrechus quadrupes, has been already noticed, and no other member of the family requires to be described. A *Brenthus* was sent to me as a borer from Wynaad, but I have never noticed its depredations, or secured the insect myself on a coffee plant. Several large white grubs, the larvæ of beetles, attack the roots of the coffee tree, gnawing out great gaps in them, or even cutting them through entirely. They live under ground, and are usually found near rotten stumps or logs, in which they are bred. I have never been able to get one to pass into the imago state, so as to identify it, but believe that there are two or three species of the white grub, and that they belong to the Lucanidæ or Melolanthidæ.

Orthoptera.

In most decayed logs there are swarms of cockroaches, but as they do not do any harm to the coffee, they do not require any special notice here. It is otherwise with another member of the order, a small but voracious locust.

Locusta Coffeæ—(See Pl. vi.)

Of small size; tegmina and wings brownish and deflexed; antennæ short and filiform; eyes large and brilliant; abdomen reddish; femora with brown transverse bars on a yellowish ground; tarsi with three joints, of which the basal one is long and marked with two depressions on the underside like additional joints. This insect is most abundant in dry seasons, and seems to select a sunny sheltered spot, where the coffee is luxuriant and juicy, as the scene of its depredations. It may be found in large numbers on the leaves which it destroys, in the way shewn in Pl. vi., and when these fail, it often gnaws off the bark from the tender young wood. The want of the leaves is sure to cause the loss of crop for one season, and the injury done to the branches generally kills them, and causes the primaries to put forth a number of irregular shoots. Hitherto the insect has not fortunately been very numerous, but I have seen several acres of trees completely stript of their foliage by it, and as it is one of a family that is apt suddenly to appear in overwhelming numbers, the planter, when it invades his property, should carefully use every means in his power for its destruction. The most effectual way for accomplishing this is the collecting of the perfect insect on the trees. In France, the Government have a fixed scale of prices for the eggs and perfect insects, half a franc being paid for a kilogramme of the former, and a quarter of a franc for the same quantity of the latter—*(Westwood on Insects, vol. 1, p. 459.)*

Lepidoptera.

Several of this order attack the coffee, and one of the Hepialidæ destroys great numbers of the invaluable charcoal tree. The larva is of very large size, and its presence in a tree is indicated by a large ball of wood-powder on the exterior, fastened together by delicate silken threads. On removing this, the mouth of the hole will be seen, and on splitting up the stem, it will be found that one branch of the tunnel generally runs in an upward, and another in a

downward direction. The grub is from three to four inches long thick, fleshy, and of a pale red colour. It has six pectoral, eight ventral, and two anal feet; and is a very powerful creature, struggling violently in the hand and attacking vigorously, with its powerful jaws, the cork of a bottle in which it may be confined. The chrysalis is smaller, of a red colour, and rests about three months. Its abdominal segments are furnished with transverse rows of minute reflexed spines, and some weeks before the moth emerges, moved by some wonderful instinct, it pushes itself up by means of these, and clears away the blockading mass of wood-powder from the external opening, so that there may be nothing to prevent the escape of the moth. The moth measures about three and a half inches across the wings, which are of a greyish brown colour, the upper ones being clouded with a decided brown. The antennæ of the female (I have not seen the male), are very short and filiform. The wings are deflexed in repose, and furnished with a complicated series of strong nerves. Abdomen elongated, and the female, when touched, discharges with some force a great number of white round eggs, which shortly turn black. The holes made by this formidable creature render the soft-wooded stem of the charcoal tree very weak, or cause it to rot from water entering during the monsoon. The grub may be killed by passing a long piece of copper wire down the tunnel, and also by closing the opening with a peg of soft wood.

Zeuzera Coffeophaga.

This is the well known "Red Borer" of the coffee zone.

Moth.—(Fig. 4, Pl. v.)—Has a considerable resemblance to the wood *Leopard-moth* of Europe. It is not often seen, although the larva is common enough, and this may arise from its rather conspicuous colours and slow flight, which would enable its enemies to discover and destroy it readily. It measures about one and three-quarters of an inch across the wings, which are pure white, spotted with small dots of a blue-black. The thorax is marked with a large dark spot, and the abdomen with rings of the same colour, and altogether the moth is one of the prettiest in India. The antennæ of the male are bipectinated to about their middle (see Fig. 4, Pl. v), and are beautiful objects under a low power of the microscope.

Larva.—(Fig. 1, Pl. v.)—The larva is from one and a half to two inches long, and as thick as a quill. It is clothed with a very few

scattered hairs, and is called the Red Borer, from the red colour of its back. The head is yellow, and the thoracie and anal plates black. Its presence in a stem is indicated by little pellets of wood-dust at the foot of the coffee tree, and on looking up the stem, the hole will be found from eight to eighteen inches from the ground. It attacks trees both young and old, but seems to be most fond of the former It usually scoops its tunnel right in the centre of the stem, with here and there some lateral offsets, as will be seen in Fig. 3 *a*, *a* Pl. v. Sometimes it sweeps round in cork-screw fashion near the entrance to the tunnel, and if the stem is not of considerable diameter, this freak renders it so weak, that the slightest force is sufficient to snap it across. The tunnel has usually an upward direction, but not unfrequently there is also a descending branch. When about to enter into the chrysalis state, it retreats to a safe part of the tunnel, and having prepared a delicate silken cocoon, assumes the appearance shewn in Fig. 2, Pl. v. While in this state, it is quite capable of making certain movements, but remains quiescent, unless disturbed, for from two and a half to three months. The larva appears to work chiefly during the night, and is probably hatched in the ground at the foot of the tree. When the stem is much damaged, the foliage gets sickly and drooping, and sometimes the tree dies. If not much injured, the external opening should be closed with a wooden peg, which causes the death of the borer, and the tree will then in all probability recover. If the damage is considerable, the bored portion should be removed with a saw, and the young shoots treated as recommended, when speaking of trees injured by the white borer.

Agrotis Segetum.

For some years past a dark-coloured grub has been known in Coorg as the "Ringer," a name very applicable, as it destroys the young coffee tree by gnawing off a circle of the bark just above ground. It does not appear annually, but in certain seasons comes forth in vast numbers, clearing away every plant over an area of fifty or sixty acres. I have never succeeded in getting the larva to pass through the chrysalis stage, but from the appearance and habits of the grub, have not the slightest doubt that it is the larva of the *Agrotis Segetum*. In Europe the insect is well known, and is a great enemy to cultivated plants, in some seasons doing immense damage to grain, turnips, beet-root, &c.

Moth.—(See Fig. 6, Pl. v., from Normandy's Agricultural Chemst.) The moth is somewhat variable as to size and colour, but generally measures about one and three-quarters of an inch across the wings, which are of a clouded brown colour. The lower wings are of a greyish or bluish white colour. It is very rarely seen.

*Larva.**—The grub is usually quite an inch long, and about the thickness of a quill. It is of a dingy brown colour, with black head and lateral dots. It is most common in the dry months, immediately after the monsoon. It only attacks young trees, and is, therefore, very destructive to plants in the nursery and when first put out. The ring of bark, gnawed off by its formidable mandibles, is near the surface of the ground, and hence, as the insect is not visible during the day, planters at first thought their trees were *wind-rung*, that is, deprived of their bark by the rubbing of the stem against the ground when swayed by the wind. The grub buries itself in the earth at the foot of the tree during the day, and comes forth at night to feed; and, considering its size, the damage it does is truly wonderful, as a stem, from which a complete ring of bark has been removed, is sure to die. Fortunately, its ravages seem to be confined chiefly to the dry eastern portions of the coffee zone. It sometimes invades gardens, and attacks most of the European vegetables cultivated there. When its presence is discovered on an estate, the coolies should be taught to collect the grubs, and, to ensure diligence, each one should be made to display what he may have gathered during the day in the evening. Quick-lime applied to the ground kills them, and at the same time benefits the soil.

Homoptera.

This order contains some useful insects, and a number which are most destructive to cultivated plants. One of the best known is the large Cicada, or *Knife-grinder*, which makes the woods resound with its harsh noise. Of those that are especially useful, I may mention the Coccus Polonicus, or Scarlet Grain of Poland used as a dye; the famous Coccus Cacti, the cochineal insect; the Coccus lacca of this country that produces lac; and the Coccus Ceriferus, or wax insect of the East Indies, which is employed in the production of white-wax. Of the noxious species, there is an immense number, a great many garden and forest trees being liable to their attacks, and their small size and powers of propagation render their extermination im-

* See Fig. 5, Pl. v. from a specimen in spirit.

possible. One much dreaded in England is the *Hop-Fly*, which in some seasons does such injury to the hop crops, as to occasion a decrease of £200,000 in the usual annual amount of duty paid to Government. The vine, pine-apple, and orange are also subject to the invasions of minute homopterous insects, called *Scale*, that do the plants a great deal of injury; and in the West Indies, a tiny creature, Delphax Saccharivora, ravages sugar plantations, often killing the canes. None, perhaps, have occasioned more loss than the Coffee Bug. Prior to the appearance of the borer, it was reckoned by the coffee planter his greatest enemy; but true it is that great evils make us forget smaller, and so the bug has come to be regarded as a minor foe, seeing that it only does temporary damage, while the dreaded borer kills the tree !

Lecanium Caffeæ, *Wlkr.*

The Bug—(See Pl. vii.)

This is the brown or scaly bug so well known, and so destructive both here and in Ceylon. Two other insects, called *bug*, viz., the *White Bug* and *Black Bug* also attack coffee, but they do so little harm in our coffee zone, that they do not demand any special notice. The bug is, no doubt, indigenous both here and in Ceylon, as it is said to appear on the orange, guava, beet, &c. in the latter, and it is often seen on the guava in this country. It seems first to have appeared in considerable numbers in Ceylon, in 1845, and spread with such rapidity, that in 1847 it was an object of general alarm. About this time, the late Dr. Gardner investigated the subject, and thereafter presented a very complete memoir regarding it to the Ceylon Government. As the male and female, when mature, are very different in appearance, they will require to be described separately.

Male.—Head sub-globular ; eyes black ; antennæ eleven-jointed and with tufts of hair at the tips ; thorax somewhat heart-shaped ; wings two, horizontal, delicate membranous, and two-nerved ; abdomen with two lateral and one long central appendage. Of pinkish brown colour, but not often seen on the bushes.

Female.—Apterous ; capable of walking about until nearly full grown, when being impregnated, she becomes fixed to a young shoot, or the margin of the under surface of a leaf. She is then a conical-like scale of a brown colour, which to the naked eye looks smooth, but under the microscope, has a strong resemblance to the back of a tortoise. This scale contains several hundred eggs, which are

smooth, oblong, and of a pale flesh colour, and are hatched within it. When the young ones come out, there is but little difference in appearance between the sexes; but in a little the males betake themselves to the underside of the leaves, and the females to the young shoots.

The male does not derive any nourishment from the tree, but the female has a proboscis with which she incises the bark and drinks the sap of the tree. The eggs being very minute, are easily transported from one place to another, by adhering to clothing, birds or animals, and this may account for the apparently mysterious way in which the pest often makes its appearance on an estate. During the first year of invasion it does not do much harm, but in the second year, owing to the increase in the number of scales, a good deal of the foliage is destroyed, and a portion of the crop turns black and falls off. About this time, too, a saccharine substance, called the *Honey-dew*, is secreted, apparently by the bugs, and shortly the plant acquires a dark warty and sordid appearance. A careful examination will now discover the presence of a fungus, which gradually covers the branches and leaves. In the third year the plant will probably be completely devoid of leaves, and, of course, bear no crop. The fungus which spreads over the plant in a dense black felt-like covering, was termed the *Triposporium Gardneri* by Berkeley, and *Syncladium Nietneri* by Rabenhorst. The bug seems to appear first in sheltered damp hollows and ravines, but when once fairly established, spreads over every part of an estate. It generally disappears in a few seasons, but leaves the trees in a weak and exhausted state, and is very apt to return. It seems to be most prevalent in wet seasons. No effectual remedy has been discovered for it, and Dr. Gardner thought that the ravages of the insect were entirely beyond human control. Mr. Neitner says, hand-rubbing will destroy an immense quantity of the bug, but is afraid the permanent good effect is but trifling. High culture, he also remarks, has the effect of throwing off the pest; and tar applied to the roots of the tree seems to be a valuable remedy. The bug has at times been very prevalent in Coorg and Wynaad, but is not so well known in Mysore, and does not appear to be common or destructive on shaded estates.

IX.—DISEASES TO WHICH THE COFFEE PLANT IS LIABLE.

All plants under the care of man are liable to disease, but fortunately the distempers that attack the coffee are not very numerous or serious. Disease in plants may arise from any of the following causes ;—

I. Exhaustion of, or noxious elements in, the soil.

II. Excess or deficiency of light, air, heat or moisture, or noxious substances in the air.

III. Improper culture.

IV. Mechanical injuries from winds, attacks of animals, &c.

Everything, too, that weakens a plant, such as exhaustion from overbearing, or unfavourable seasons will, of course, predispose it to disease. One of the most common diseases of the coffee is what may be called,

Stump Rot.

It is a well known fact that few plants will grow in the shade of certain trees,—the Tamarind, for instance. This upas-like effect seems in some cases to be produced by deleterious gases given off by the leaves of the tree, and in others to arise simply from the ground having been deprived of those elements requisite for the nourishment of the smaller plant. In *Stump Rot,* the coffee dies off persistently around a stump left in clearing. Year after year the plants are renewed only to perish, and leave an unsightly gap. It is difficult when a stump has been charred and is partly decayed, to discover to what tree it belonged, but I am inclined to think that the trees which produce Stump Rot are chiefly species of Ficus, the Cinnamon, and some of the Meliaceæ and Bignoniaceæ. Plants affected with this disease gradually wither and die, as soon as their roots begin to descend and take hold of the ground. On examining the roots, they will either be found simply rotten, or decayed and occupied by a small fungus. In the former case, the immediate cause of death is some noxious gas, generated during the process of decay in the roots of the forest tree. In the latter, the coffee plant is first sickened by the presence of some hurtful substance in the soil, on which the spores of a fungus, growing on the decayed roots of the forest tree, fasten on those of the coffee, and shortly complete the work of destruction. The only remedy appears to be to dig up the roots of the stump.

Rot.

This disease is most common during the rains. It attacks the leaves which rapidly turn black and fall off, on which many of the berries fall down, and those that remain are imperfectly ripened. Rot is caused partly by bad drainage, which allows the water to lodge about the roots, and partly by the overcrowding of the branches which prevents due exposure of the leaves. The results are, that the plant is constantly gorged with moisture, and circulation, perspiration and assimilation being nearly arrested, the foliage decays in the manner described. The remedies for this disease will be thorough drainage and free pruning.

In some cases the entire plant dies, the leaves turning a sickly yellow, and the rot attacking the roots. This, too, arises from defective drainage.

Lethargy.

This disease attacks plants which have been improperly planted, or put out so late in the monsoon, that they have not had time to grow a sufficiency of fresh roots before the dry season. In consequence of this, they never make a proper *start*, and linger on, just shewing by a few yellow leaves that they are alive, and no more. In such plantings there are always a great many deaths, and even when the trees live, they never acquire the strength and vigour of healthy well reared ones, and are apt to be attacked by borer and infested with lichens. The best remedies for this condition are irrigation, if practicable, or *mulching*, which consists in littering the ground about the roots with grass, so as to retain the natural humidity of the soil. Where grass cannot be got, stones may be advantageously employed.

Langour.

This disease is most commonly seen in the bamboo districts, where the plants gradually become decrepid and die prematurely, partly from exhaustion by excessive bearing, and partly from the soil becoming deprived of those elements which the coffee requires for its nutrition. In general terms, the cause of langour may be stated to be drought, and barrenness of soil. In several instances I have known it to arise after the plants were five or six years old, from their roots having encountered a bad subsoil. The decay of langour is quite distinct from that of age, being premature, and characterised by the decay of the tender branches, yellow colour of the leaves, and failure of crop. If not arrested, the plants die off in

a few years. When the subsoil is at fault, no remedy will be of any avail, but in other cases much may be done by the free application of manure, and shade to protect from the sun.

Lichens and Mosses.

As a rule, trees covered with those parasites are far from healthy, and it is a question, on which some difference of opinion prevails, whether the debility is the cause or the result of their presence. So far as my own observations go, I am inclined to think that they induce disease in cultivated plants. That they prey on the secretions of the tree to which they are attached, and do not draw their entire sustenance from the atmosphere, is manifest from the fact that lichens contain substances that could never, by any possibility, have been derived from air or rain. What is more strange, we often find in a lichen something that does not exist in the tree on which it grew, so that it would appear that these curious organisms cause, in some way, the fostering tree to draw from the soil and yield up to them materials not used in its own economy. As a rule, lichens and mosses indicate bad drainage, and improvement in this particular, and the application of lime to the soil, will generally keep them in check. When the stem is much choked with them, they should be removed with a curved iron scraper, and the scraped surface painted with a mixture of cow-dung and quick-lime in water. The addition of a small quantity of sulphur to this recipe seems to increase its efficacy.

X.—OTHER PLANTS WHICH MIGHT BE CULTIVATED BY EUROPEAN SETTLERS IN THE COFFEE DISTRICTS.

Since the devastation caused by the borer became so great and general, many coffee planters have been anxiously seeking for some plant which they might profitably cultivate in fresh soil, or in lands in which the coffee has died out. In short, impressed with the precariousness of coffee crops, they have been looking for a second string to their bow, another staff on which to lean. The number of plants yielding valuable commercial products, for which the climate of the coffee zone is suitable, is by no means great, and I shall only notice such as might be thought worthy the attention of the European, who will not be pleased with the small profits that satisfy and maintain the natives of the country.

Bœhmeria Nivea.

Rheea or Chinese Grass Cloth.

This plant, which produces the fibre from which the beautiful Chinese grass cloth is made, has now been cultivated in India for some years. Attention was recently drawn to it by a despatch from the Secretary of State for India, intimating that it was worth in the English market from 60 to 80£ per ton, owing to the discovery of some process which facilitated the extraction of the fibre, and produced some change in it, that rendered it an excellent substitute for worsted in the manufacture of goods, in which that substance is mixed with cotton. The Bœhmeria is a native of China and Assam, and is cultivated with very great care in the former. It is raised there from seed, and is carefully manured. Throughout Lower India generally it does not seed, but is easily propagated by division of the roots, layers, and even cuttings, if the weather is damp. Dr. Macgowan gives the following information, as to the mode of culture in China (Vol. VI, Journ. of Agri-Horti. Society of India). "The roots are to be cut in pieces of three or four fingers' length, and are to be planted in May, half a yard apart, and watered every three or four days. On the appearance of the blades, use the hoe and water them; they will be mature for cutting in the second year. In the course of 3 years the roots become unfruitful." "It yields three crops every year. The first cutting takes place in June. Care is to be taken not to cut the young shoots, keep therefore an inch from the ground." After each cutting, the plant is to be covered with manure and watered, but not by day, unless it be cloudy.

Manipulation.—"On being cut, the leaves are carefully taken off with a bamboo knife by women and children, generally on the spot. It is then taken to the house and soaked in water for an hour, unless it is already wet by recent showers; in cold weather, the water should be tepid. After this the plant is broken in the middle, by which the fibrous portion is loosened, and raised from the stalk; into the interstice thus made the operator, generally a woman or child, thrusts the finger nails, and separates the fibre from the centre to one extremity, and then to the other. Steeping process is very easy." "The next process is scraping the hemp, to facilitate which the fibre is first soaked in water. The knife or scraper is about two inches long, and its back is inserted in a handle of twice its length. This rude implement is held in the left hand; its edge, which is dull, is

raised a line above the index finger. Strips of hemp are then drawn over the blade from within outwards, and being pressed upon by the thumb, the pilous surface of one surface and the mucilaginous part of the other are thus taken off. The hemp then rolls up like boiled tendon. After being wiped dry, it is exposed to the sun for a day, and then assorted, the whitest being selected for fine cloth." Thereafter it is partially bleached by boiling, and then the fibres are separated by the finger nails of women and children. These latter processes would not seem to be necessary to fit the fibre for the English market, and indeed the maceration in water to aid in cleaning the fibre must be performed with the utmost caution, otherwise it may be damaged both in colour and in strength. The Rheea, of which plants were got by me for the Agri-Horticultural Society, about two years ago from Calcutta, has, with an occasional watering, grown tolerably well in the gardens at Madras, and thrives admirably at Bangalore and Mercara. It seems to like moist sheltered hollows, and if carefully cultivated. will doubtless prove fully as profitable as coffee under the most favourable circumstances ; and it is not a crop likely to suffer from bad seasons. The demand for the fibre is said to be steadily on the increase, and were some cheap machine for cleaning the fibre brought out, which it is sure to be ere long, the cost of manipulation would be so much reduced as greatly to increase the profits.

Phormium Tenax.

New Zealand Flax.

This plant is a native of New Zealand, and its fibre has for a considerable time been an article of export from that island. It has lately been introduced into the Government Gardens at Ootacamund, and thrives so well, that I entertain confident hopes of its proving a most valuable addition to the cultivated plants of our various hill ranges. It is a flag-like plant, of large size, with sword-shaped leaves, and bears its flowers on a stalk like the American Aloe. The Phormium covers millions of acres in New Zealand, growing spontaneously on any kind of soil, moist or dry, and in any locality, high or low. It, however, attains its greatest luxuriance in moist alluvial soil, and I believe it will be found to do well, with very little care, in most parts, but especially towards the western side of our coffee zone. The fibre is extracted from the fleshy leaves, which the Maories also cut into strips and use instead of cords, strings, ropes, straps

&c. They extract the fibre by scraping off the parenchyma with a shell. In 1860, the Rev. Mr. Purchas, of New Zealand, invented a machine for cleaning it, which is said to do its work well, and to be equally suited for the American Aloe, Manilla Hemp, and Pineapple. As all these grow so readily in this country, the introduction of such an implement would give an immense impulse to the production of fibres, and I would take the liberty of recommending, that Government procure one of Mr. Purchas' machines for trial in Madras. Although no country in the world is so rich in fibrous plants as India, the known methods of manipulation are so expensive and defective, that we have been able to do little or nothing with them, and they therefore remain as dead wealth.

Musa Textilis.

Manilla Plantain, or Manilla Hemp.

The cultivation of this plant on a pretty large scale, is being tried on some estates in Wynaad, and is not attended with the slightest difficulty; but the want of some machine to clean the fibre is likely to stop the experiment when it is just at the verge of success.

Ricinus Communis.

Castor Oil.

This plant, yielding the well known Castor oil, thrives admirably on the driest and most barren soil in the coffee districts, and might be advantageously cultivated on tracts of ground on which the coffee has not been found to thrive. From forty to fifty per cent. of oil will be got from cleaned seed of good quality, and the oil is by no means difficult to prepare by the process which produces the *cold drawn oil.* There are two varieties of the plant, one yielding a *small* and the other a *large seed*, and it is generally stated that the the oil extracted from the latter has a disagreable appearance and smell, and is unsuited for medicinal purposes. From a series of experiments instituted by me, some years ago, I am able to state, that there is no foundation whatever for this opinion. The method of preparing the oil is as follows:—Free the seeds of stones and dirt by the native sifter. Then place them in a large mortar, cut out of wood or stone, like that used in the native oil mill, and beat them with a rice pounder slightly so as to crack the husks, but not to cake the seeds. The husks must now be removed by hand, an operation which can be performed by women and children. The seeds should

then be pounded in the mortar, and if the temperature of the air is low, should be warmed by steam heat, after which they are put in small bags of woollen cloth, made in England for the purpose, and called *sacking*, or strong gunny, and the bags arranged alternately with plates of iron previously warmed, in a hydraulic or powerful screw press. As the oil is squeezed out, it should be received in clean tin pans, and when the flow has ceased, the bags should be taken out and their contents again pounded and squeezed as before. Generally speaking, this part of the process requires to be repeated three times, so as to get the whole of the oil, which will then be found to be somewhat *muddy*, from the presence of albumen and other impurities. To get rid of these, add one part of filtered water to eight parts of oil, and boil these over a brisk smokeless fire, until the whole of the water has been evaporated, which will be known by bubbles ceasing to rise. Then remove at once, and allow to cool, when the dirt will all be found adhering to the bottom of the boiler. This is the nicest part of the whole operation, as if the oil is kept on the fire one minute after the water has been driven off, it will acquire a burnt or empyreumatic flavour ; which greatly reduces its commercial value. Oil prepared carefully in this way is as clear as water, and has scarcely any taste or smell. It may me sent to England in tins, packed in wooden cases. The most expensive part of the process is the removal of the husks, and if some machine, say a modification of the disk coffee pulper, could be invented for performing the operation, the profits would be very large.

Cotton.

The varieties of this plant, known as *Bourbon*, *New Orleans*, *Brazilian*, and *Sea Island*, will all thrive in the coffee districts, and might be cultivated with advantage on portions of estates that have become unfit for coffee. The amount of labour necessary, and the high rate of wages are no doubt serious obstacles, but at the same time if the culture is conducted with care and on a moderately large scale, it cannot fail to yield a fair profit. To render the ground fit for the seed, it must be well ploughed and cleared of weeds, and cast into small ridges, from three to five feet apart. On the top of the ridge, a little furrow, about two inches deep, must then be made, and the seed scattered in this pretty freely, and covered in by trailing over it a piece of wood of sufficient weight. The period of sowing is a point of vast importance, and Dr. Wight recommends

that in places under the south-west monsoon, it should be done in the month of May, so as to have the plants well up before the heavy rains. If sown during the rains, the seeds rot. Sowing in May, the cotton will be ripe about the end of September or beginning of October, when fair weather, which is absolutely essential during the picking season, may be expected. Weeds may be kept down by the A-shaped horse hoe, and when the plants are five or six inches high, the earth should be banked up on the roots. Manuring will sometimes be necessary in poor soil, but generally there will be no necessity for it if the earth is ploughed deeply with a light plough of the Scotch model, so as to bring up a fresh layer to the surface. The cotton, it is said, requires to be treated as an annual, as generally speaking, the crop from two-year old plants is rather poor, and of inferior quality. However, further experience is required on this point, as I have found Sea-Island yield splendid crops for two years in succession, when the plants were heavily pruned and the soil well dug up about the roots.

Tea.

The question as to whether the tea plant can be cultivated within the coffee zone, is at present being subjected to the test of experiment, and until the result is seen, it would scarcely be safe to plant extensively, as even on the upper heights of the Neilgherries, which were thought peculiarly suited for the tea, the trials have not by any means proved so successful as was anticipated. That the plant will grow in the coffee districts, there cannot be a doubt, but whether it will produce leaf of such quality, and in such quantity as will render its culture profitable, is somewhat doubtful. All the plants that I have seen in Wynaad, Coorg, and Mysore, had a constant tendency to run to seed, which would of course prevent their producing the necessary flushes of leaves. Probably some change in culture may obviate this, and with a view to prevent it, irrigation during the hotter months is deserving of a trial. The degree of elevation requisite for tea culture depends a good deal on the rainfall, &c., but I hardly think the necessary climatic conditions will be found at any site under three thousand feet above the sea. The plant known as the hybrid seems the best suited for Southern India, and the stiffish moist loamy clay of the heavy jungle tract the best adapted for its growth. As there are several excellent hand-books on tea planting, it is unnecessary for me to enter into particulars on the subject.

Cinchona.

The only species likely to thrive in the coffee zone is the Cinchona Succirubra, and its large leaves and soft young wood suffer a good deal from the wind during the south-west monsoon. As a commercial speculation, or means of livelihood, cinchona culture is not attractive, as the capital invested must remain, for a very long time, totally unremunerative, and we have yet to learn how many years the trees will live if deprived of a great portion of their bark and some of their branches annually. Possibly as our experience enlarges, it may be found that the plant will not require so much care in the way of weeding, &c., as has hitherto been bestowed on it, and I think it would be well, that by way of experiment, some acres should be left without more attention than what is devoted to plantations of forest trees in England. At present, planters are not likely to extend operations beyond the putting down a few hundred trees, to yield in future years a supply of bark for their coolies ; and full instructions regarding Cinchona culture will be found in Mr. McIvor's admirable Manual.

Theobroma Cacao, or Chocolate Tree.

The Chocolate tree is a native of tropical America, and is now cultivated both in the western and eastern hemispheres. It is raised from seed, and the ground previous to sowing should be well *trenched* and arranged in small ridges. The seeds are then to be put—say six or eight inches apart—in shallow ruts on the top of the ridges, and lightly covered with soil. To protect them from the sun, small *pandals*, like those used in coffee nurseries, must now be put up, and watering should be carefully attended to, but not too much applied, as when it lodges, the seeds are liable to rot. The plants should remain in the nursery until from fifteen to eighteen inches high, when they may be transplanted with balls of earth attached to the roots. The Cacao requires rich, deep, and moist forest soil, and the situation should be such as will admit of irrigation, when necessary. The plants should be put out in rows, so that there will be from twelve to fifteen feet between every two plants, and the pits should be twice as deep, and somewhat broader than those recommended for the coffee. To protect the young plants, which are particularly tender, from sun and wind, Plantain, or the Erythrina Indica must be put down between every second row. The Spaniards from this use of it, call the Erythrina—*Madre de cacao.** When about two years

* Porter's "Tropical Agriculturist."

old, the tree usually puts forth a number of branches near the top, but all are cut away, save five or six. Flowers appear in the third year, but these should all be removed, so as to prevent its fruiting until five years old. When growing the ground must be regularly weeded, and suckers carefully removed from the trees. When full grown, a Cacao plantation is said to be a beautiful sight, and there is perhaps no crop "which calls for fewer cares or less labour."* As the fruit ripens, it changes from a green to a purplish or yellow colour, and should not be gathered until quite ripe. When collected, it is cut open and the seeds separated from the pulp, and put into a heap of sand until they undergo slight fermentation, which frees them from adhering pulp. To prevent the fermentation going too far, the seeds must be often stirred with a stick, and fresh sand added each time, so as to absorb the moisture. In three or four days they will be quite or nearly dry, and then they should be dried in the sun on a platform, like that used for drying coffee. Care must be taken in case of rain to remove the seeds under cover, as it would completely destroy them, and they must be exposed until perfectly dry, which will be known by their splitting when pressed, and not fermenting when heaped together. They are then put in bags or boxes, and ready for export.

Manihot Utilissima, or Janipha Manihot.
Tapioca Plant.

The Tapioca, or Bitter Cassava, a native of South America, is now cultivated about Madras and Bangalore pretty extensively, and will grow readily in any part of the coffee zone. It is propagated by cuttings, which should be planted in cleared ground, at the distance of from two and a half to three feet apart. They should be put down in the month of June, and the ground kept free of weeds until they cover the soil and subdue the weeds. In the month of March or April following, the roots which contain the tapioca will be fit for use. They are of a dark colour, of considerable size, and contain along with the starchy matter, a poisonous narcotic substance, which is got rid of in the process of preparation. When taken from the ground they are washed, peeled, and reduced to pulp by a grater fixed on the edge of a thick wooden wheel. The pulp is received in a trough placed below the wheel, bruised, and then washed in a large tub filled with clean water. The resulting turbid fluid is passed through a fine hair-sieve, so as to free it from

* Porter's Tropical Agriculturist.

gross impurities, and allowed to rest for some time, when the tapioca will settle at the bottom. When this has taken place, the supernatant fluid is drawn off, and fresh water added. To render the tapioca perfectly wholesome and white, the washing process must be repeated at least five times. The pasty mass is then removed, put into squares of strong cloth, and partially dried by folding over the sides and twisting the ends in opposite directions. This completed, it is spread out on hot iron plates, and agitated so as to give it the granular form in which it is sent to market. The tapioca grows best in an open rich soil, but being rather exhausting, the ground will require to be manured after the second or third crop. Arrow-root (Maranta Arundinacea) will also grow readily, and is prepared from the roots by rasping and washing, as in the case of the tapioca. It does not, however, require the aid of artificial heat, but when clean, is simply dried in the sun.

Myristica Officinalis.

Nutmeg.

It seems highly probable that this plant might be successfully cultivated in the western parts of the coffee zone, as a wild species is very abundant throughout the heavy jungle tract, and if so, it would prove a great acquisition to the European planter, as the profits are very large. On the other hand, the opening of a Nutmeg plantation is attended with greater expense than a coffee, and no crop need be expected until the trees are six or seven years old. The land selected for nutmeg culture should be well sheltered and not steep, and the soil rich and open. In clearing, belts of trees should be left to protect the plantation from the south-west and other winds to which it may be exposed. The first step is to get fresh ripe nuts which should be planted at the distance of one foot apart in a nursery, protected from the sun as usual. The ground must be kept clear of weeds, and water applied in moderate quantity daily. The seeds germinate in from thirty to sixty days, and when the seedlings are from two to three feet high, they are fit for transplanting. The ground in which they are to grow should be well cleared of weeds and roots, and large pits, in rows, opened for their reception at intervals of two feet. At first they will require the protection of plantain trees to screen them from the sun and wind. Thereafter the ground between the rows is to be kept open and clear of weeds by the plough, and a basket or two of cow-dung must be applied

every year to the roots of each tree. When about five years old, the shade of the plantains may be dispensed with, but the manuring must be continued, the quantity of manure being increased in proportion to the size of the tree. The nutmeg is a diœcious plant, that is, having male or barren flowers on one tree, and female or fertile upon another. The one sex cannot be distinguished from the other, until the flowers appear, and thus considerable loss results, as the greater number of the male trees have to be cut down. Probably, however, this might be avoided by grafting branches of a female tree on the males. The trees come into full bearing when ten years old, and eight pounds of nutmeg and one and a quarter pounds of mace may be expected from a good tree annually. When the fruit is ripe, the outer covering bursts, which is the signal for gathering it. It is then divested of the mace, which is spread on mats in the sun to dry. The nuts are then taken to the drying house, and subjected to a temperature of 140° Fhr. by means of smouldering fires. When thoroughly dried, so that the kernels rattle when the nuts are shaken, the shells are cracked with mallets, and the nutmegs removed. Sometimes they are dipped in a mixture of salt water and lime before packing, to prevent the attacks of insects, but the rolling of them in sifted quick lime seems to answer the purpose as well, and to be less likely to injure the spice.

XI.—FUTURE PROSPECTS OF COFFEE CULTURE IN SOUTHERN INDIA.

In previous chapters such casual remarks have been made on this subject, as will render it unnecessary to do more here than give a brief summary of my conclusions. The experiments that have been going on for years have proved that the climate and soil are by no means inimical to the plant, inasmuch as it has lived and produced crops when badly cultivated or neglected, and there can now be no doubt that, under better treatment, it would prove a safe and profitable investment. Taking each district as a whole, the average yield per acre has scarcely been sufficient to cover working expenses, and most planters are beginning to feel that something must be done to render crops larger and more certain. In some instances, no doubt, the returns have been satisfactory, but such success has not been enduring. A rich soil and favourable climate may, for a few years, have kept the plants in a vigorous and fruitful condition, but sooner or later a change has come, for

no soil, whatever may be its natural fertility, can go on for ever producing exhausting crops such as the coffee, unless fresh materials be added to it, in the shape of suitable manure. Indeed, nature herself sets us an example in this matter by fertilising the natural meadow with the withered carpet of grass that clothed its surface, and the forest by dead leaves and herbaceous plants. In nearly every coffee-producing country in the world, the necessity for manuring is now practically acknowledged, and where it is not resorted to, the reckless system is adopted of abandoning old clearings so soon as they get unproductive, and opening fresh soil. Coffee culture in India is passing through a crisis not unlike what it did in Ceylon, and many years ago the planters there began to see the necessity for manuring and high culture, and by resorting to these, undoubtedly saved themselves from ruin. It cannot, therefore, be too strongly impressed on the planters of Southern India, that their fate is, so to speak, in their own hands. If they adhere to the present bad system, the poor success that has hitherto attended their labours will still cling to them, but should they be induced to adopt a better mode of culture, coffee planting will soon become fairly remunerative, and regain the confidence of the public. In reviewing existing systems, I have pointed out their defects, and so it will suffice now to say that the planter *must manure freely, keep the ground cleaner, establish better drainage, prune more skilfully and regularly, and dig his ground annually.* To carry out these improvements will cause a considerable increase in expenditure, and this is what forms such a barrier to their adoption, as some proprietors are disinclined, and others unable to spend more money. To meet this difficulty, I would suggest the abandonment of all bad or inferior land, for coffee is not so very remunerative on good, that the planter can afford to farm what is bad. On nearly every estate there is from eight to ten per cent. of land so absolutely barren, that no care could render it productive, and yet, for appearance sake, it has been kept up year after year at great expense. Of course, there can be no question about the propriety of resigning such ground back to the keeping of nature, and in addition there will always be a proportion of land so poor, that it had better be left uncultivated. This would then permit of much more money being spent on what is really worth cultivating, and I feel assured that the profits of a property thus shorn of its bad pieces and well worked up would be at least satisfactory. Indeed, I would even go a step farther than this, and

recommend the man who has opened out three times as much land as he has capital to cultivate, to abandon two-thirds of it, for poverty in the planter means bad culture on the estate, and one acre well taken care of will be more profitable than ten neglected. The present indeed, apart altogether from the ravages of the borer, is a most critical time for coffee culture in Southern India. Other coffee-producing countries, both in the East and West, are year by year increasing their exports of the famous berry, which has had the effect of causing a considerable reduction in prices in the English and continental markets. At the same time, the cost of labour and expenses generally here are increasing and likely to increase, while the average yield per acre remains stationary or grows less. Unless, therefore, the Indian planter can increase his crops and profits by an improved system of culture, he must inevitably ere long be driven vanquished from the field. It seems quite certain that the prices that have for some years been got for coffee will never be realised again; but on the other hand, there seems no reason to anticipate that they will ever be much lower than they are at present. I have already spoken fully of the place which India occupies amongst other great coffee-growing countries, and it only remains to be said here, that she is perfectly able to hold her position, provided her planters will be wise in time, and not defer improvements until ruin is staring them in the face.

With regard to the ravages of the borer, although I believe that the insect will never leave the coffee districts, and will always be ready to prey on badly cultivated and unshaded trees, still there can be no doubt that the recent disastrous invasion is of an extraordinary and transient nature, and will, even if left in the hands of nature, gradually pass away. Past experience of similar outbreaks of destructive insects in other parts of the globe lead us to expect this; but at the same time it is the planter's duty to do all he can to exterminate the pest; and to adopt such measures as will hereafter keep the enemy at a distance. Enough has been said regarding expedients for checking the ravages of the borer on infested estates, and experience has shewn that in *shade* and *high culture* we have preventives that leave nothing further to be desired.

In conclusion, I would briefly say, that I entertain confident hopes of the success of coffee culture in Southern India, and by success, I mean a fair return for outlay, and not the extra-

vagant profits which have been promised by some and expected by too many. To secure this, however, the planter must take the proper course, and he is not asked to adopt a system untried and chimerical, but one which has for years been subjected to the test of experiment, and is based on those general principles that guide the cultivator of the soil in every civilised part of the world.

And now I must express my thanks to the Government of Madras, and the Commissioner of Mysore and Coorg, for the unfettered manner in which I was permitted to conduct this investigation. Such liberty has greatly facilitated my labours, and made me anxious to merit their confidence. I am also much indebted to the Collector of Malabar, the Superintendent of Coorg, and the Deputy Superintendent of Hassan, for the assistance which they gave me in collecting information, and in travelling through their districts. Nothing either could have exceeded the attention and courtesy of their subordinates. Mr. Underwood, the Deputy Collector of Manantoddy, was particularly zealous in his assistance, and to name any in Coorg or Mysore, where all were so attentive, would be invidious. To the planters and other gentlemen who furnished me with much valuable information, and invariably received me with kindness, I would also record my thanks, and sincerely trust that the result of this inquiry may be to help them to win that success, which their industry and enterprise so well deserve.

GEORGE BIDIE, M.B.,

Commissioner for Investigating the ravages of the Borer in Coffee Estates.

PUBLIC DEPARTMENT.

Read the following letter from Surgeon G. BIDIE, M. B.
(Here enter 3rd August 1868.)

ORDER THEREON, 19th June 1869, No. 837.

THE foregoing is the report submitted by Surgeon George Bidie, M. B., and contains the result of the investigation which he was deputed to make into the injury caused by the ravages of the Borer insect to the coffee trees in Mysore, Coorg, and the Wynaad.

2. In order to prevent further climatic deterioration by forest clearance in situations not suited for coffee culture, to regulate the natural drainage of the country in the interests of the rice cultivation, and to maintain the fertility of the coffee zone, Dr. Bidie, at page 15 of his report, suggests that " in future when application is made for coffee land, the chief Revenue Officer and Executive Engineer of the District, along with the Conservator of Forests, should inspect the block selected, and ascertain whether or not it is suited for the purpose ;" and at page 29 he lays down certain rules specifying the situations in which he considers now existing forest should be preserved.

3. The Government admit the importance of placing all possible restrictions on unnecessary felling, and resolve to refer Dr. Bidie's suggestions for the opinions of the Board of Revenue and the Conservator of Forests.

4. Fifty copies of the report will be furnished to Dr. Bidie for private distribution, and two hundred copies will be forwarded to Messrs. Gantz Brothers, who will be requested to sell them on commission at Rupees 2 per copy.

5. The Accountant General is requested to report what the entire cost of Dr. Bidie's investigation has been, and the Government consider that the time spent by Dr. Bidie in the territories of Mysore, Coorg, and Madras respectively, would be the fairest principle of division to adopt in apportioning the cost among the three Governments.

6. The Government have perused with much interest Dr. Bidie's able and exhaustive report, and request that gentleman to accept their best thanks for it and for the labour which he has expended in the investigation.

(True Extract.)

(Signed) R. A. DALYELL,

Acting Secretary to Government.

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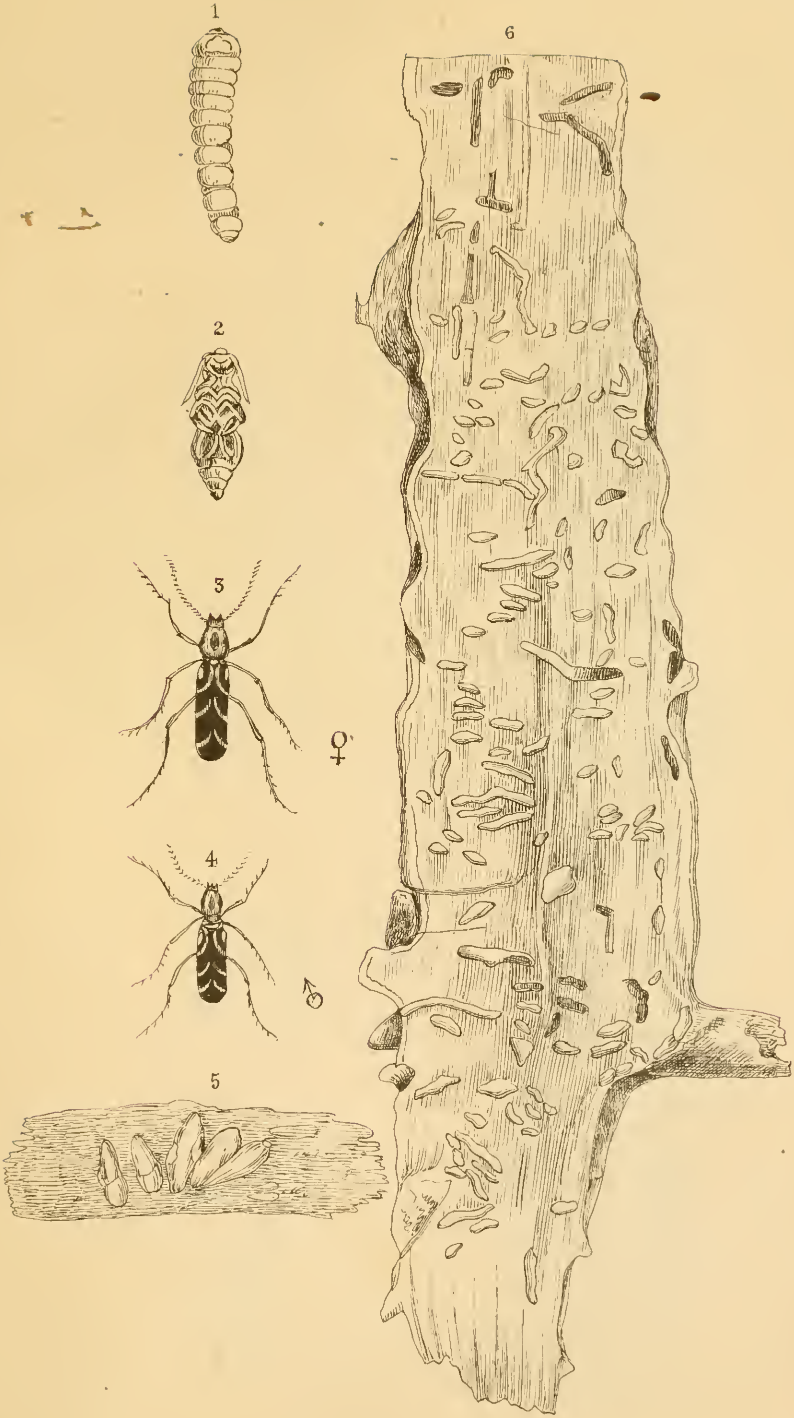
PLATE. III.



DRAWN BY C. MOORTHY. AND LITH^D. BY R. J. BALDREY GOV^T. LITH^C. PRESS FORT S^T. GEORGE NOV^R. 1868.

PLATE. IV.

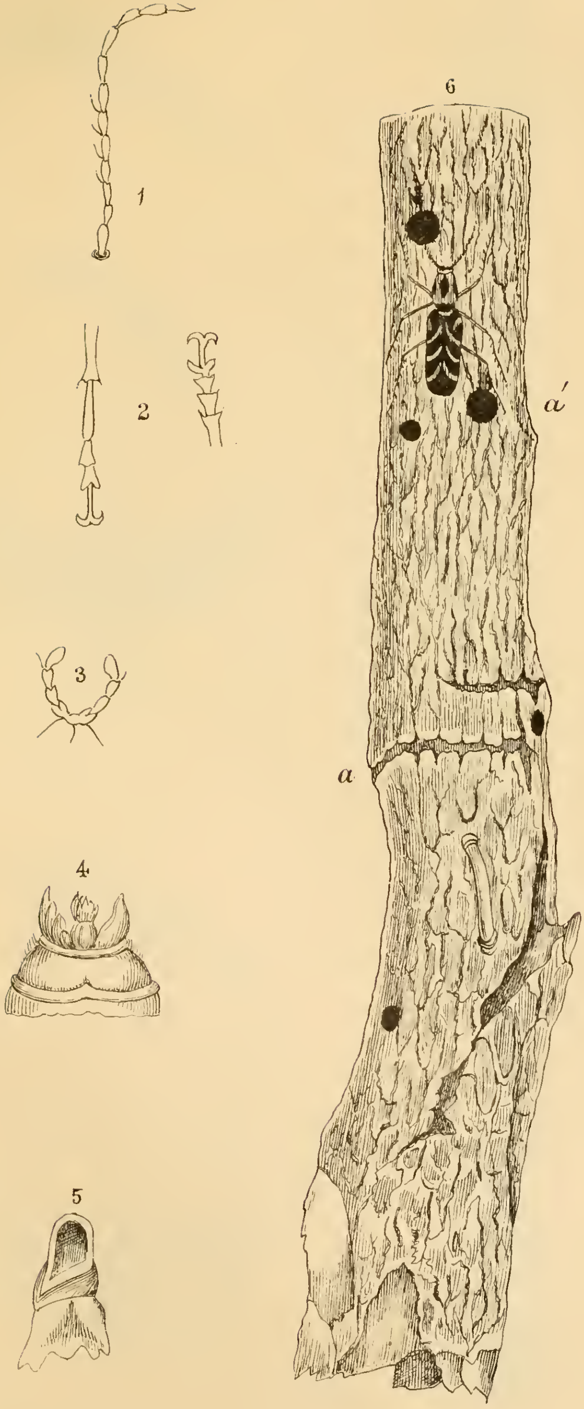


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PLATE.V.

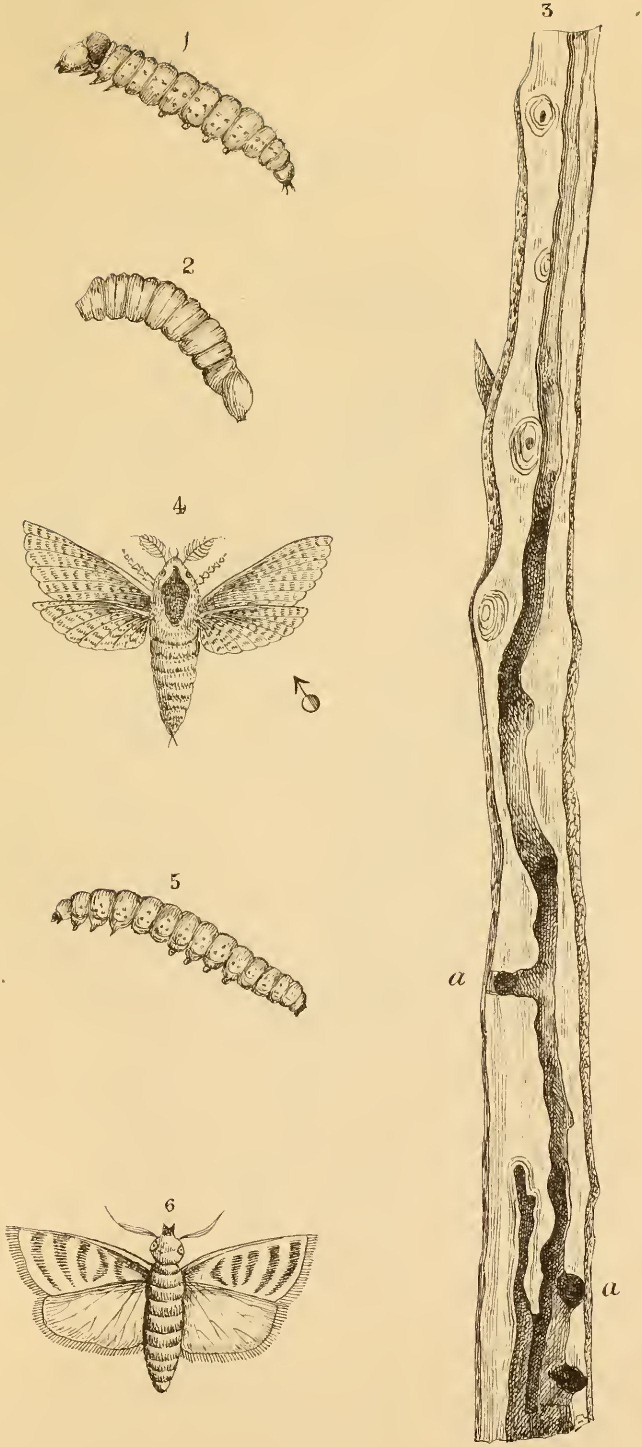

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PLATE. VI.

DRAWN BY C. MOORTHY. AND LITHD BY R. J. BALDREY GOVT LITHC PRESS FORT ST GEORGE NOVR 1868.

PLATE VII.

(FROM A WOODCUT IN TENNENTS NAT: HIST: OF CEYLON.)

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